YUMA PROVING GROUND

MAIN POST WATER TREATMENT FACILITY

OPERATIONS AND MAINTENANCE MANUAL

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CHAPTER 1

INTRODUCTION

1.1 GENERAL

The Yuma Proving Ground (YPG) Water Treatment Facility provides the potable and non-potable water needs of the Main Post Area at YPG. In operation since April of 1986, the plant's primary purpose is to provide water users with potable water that meets or exceeds guidelines established by the Environmental Protection Agency (EPA) and US Army Environmental Hygiene Agency (AEHA). The plant's original design was based on removal of excess fluoride and Total Dissolved Solids (TDS) and to produce non-corrosive water free of bacteriological contamination. This is accomplished using two Electrodialysis Reversal (EDR) units manufactured by Ionics Inc.

The purpose of this manual is to provide water treatment plant personnel with information on the theory of processes, proper operating techniques, maintenance schedules, and safety guidelines necessary for efficient plant operations. It has been compiled from several sources of information as well as hands-on experience obtained over the years. The loose-leaf format enables changes and updating when required. The operating techniques are those currently being used and found to be the most effective at the present time. The preventive maintenance schedule outlined here should be considered the minimum requirement to obtain optimum performance of this facility. This manual does not provide specific maintenance instructions on all equipment repairs. Specific maintenance and repair information can be obtained from the manufacturers' literature available on file at the water plant. As-built process and instrumentation diagrams, construction drawings, and equipment manufacturers' drawings are also on file at the plant.

1.2 PLANT DESCRIPTION

The (YPG) Water Treatment Plant employs a 421 gpm (0.606 mgd) electrodialysis reversal system to convert brackish well water to high quality drinking water for potable use. The water produced by the two electrodialysis reversal units (hereinafter referred to as EDR units) is pH corrected, stabilized with a corrosion inhibitor, and chlorinated before being pumped to the distribution system. The water is ultimately stored in two elevated tanks with a maximum capacity of 500,000 gallons or the rough equivalent of two to three days' system usage. The stored water is critical for fire protection purposes and must not be allowed to drop below 60% level (or 300,000 gallons).

A second and entirely separate non-potable system provides irrigation water for lawns, landscaping and tree lines. The Irrigation System consists of 3 pumps, compressors, chlorinator, hydropneumatic tank, and various controls. The Irrigation System supplies water on demand and has no storage tanks.

A Location Site Plan is shown in Figure 1-1 on Page 1-3.

1.3 PROCESS DESCRIPTION

A Process Flow Diagram is shown in Figure 1-2 on Page 1-4. Raw water is pumped from Wells W and Z located offsite in the Colorado River basin, to the raw water storage tank. Level controls in this tank automatically control the two wells. Water is gravity fed from the Raw Water Tank to the Irrigation System and to the EDR process.

The irrigation water is chlorinated and then pumped directly to the system utilizing up to three pumps depending on flow demands placed on the system. Since there are no storage tanks on this system, a hydropneumatic tank maintains pressure between pump cycles. Two compressors maintain approximately 60% air volume in the hydropneumatic tank. An electromagnetic flow meter, pressure transmitter, and chlorine analyzer monitor conditions downstream of the hydropneumatic tank.

Feed water for the EDR process flows by gravity to the Off-Specification Product Recovery Tank (hereinafter referred to as the OSPR tank), through an air-actuated control valve. “Off-Spec” water is simply that which doesn’t meet the conductivity set-point requirements. During polarity reversal of the EDR units, Off-Spec water is re-circulated back to the OSPR tank to increase recovery.

Blended water from the OSPR tank flows to the EDR units, where it is pressurized, regulated, filtered, and sent to the membrane stacks in two streams. The product stream is de-mineralized as it passes once through the three-stage configuration of stacks. The brine stream re-circulates, becoming more concentrated as it does so. A continuous amount of make-up water is added to the brine stream for dilution while an equal amount is blown down thus transporting concentrated brine out of the system. Brine Blowdown is metered as it flows to the Brine Pond. The Brine Pond allows minimal precipitation of compounds to occur before overflowing into the sanitary sewer system.

Product water is treated with a corrosion inhibitor, metered, and then chlorinated as it flows to the Product Storage Tank. After 1.5 hours chlorine contact time, the water becomes "potable" and is pumped to the distribution system by one of two available centrifugal pumps. Downstream of the potable pumps, an electromagnetic flow meter, pressure transmitter and a chlorine analyzer monitor conditions prior to entering the system.

CHAPTER 2

RAW WATER SYSTEM

2.1 DESCRIPTION OF OPERATION

Raw water is supplied to the 50,000 gallon Raw Water Storage Tank by two primary wells W and Z. Both wells are controlled automatically utilizing Warrick liquid level probes within the tank. Each well receives a stop signal at 100% (or 14.2') tank level. Both wells can be operated manually if required and have a time delayed start-up of 1.5 minutes. The Raw Water Tank low level alarm activates at 58.5% (8.3') on the RIS Alarm Panel and disables the irrigation pumps so as to prevent cavitation. A separate level transmitter drives an indicator and recorder in the control room. The recorder alarms at <60% and >105%. A switch in the Control Room enables selection of standby Wells X and Y in case of Well W and Z failure.

2.2 START-UP AND NORMAL OPERATING PROCEDURE

1. Open the Raw Water Tank inlet and outlet valves. Close the bypass and drain valves.

2. Energize cathodic protection on the Raw Water Tank.

3. Place Well W and Well Z Hand/Off/Auto (H/O/A) switches in **AUTO**.

4. Monitor the wells for correct operation by observing level indicator LI 101 and trends as displayed on Recorder #4 in the control room.

5. To remove residue from the Raw Water Tank surface, place one or both wells in hand as necessary to accomplish overflow for 15-20 minutes while carefully monitoring overflow trench east of the tank.

2.2.1 SHUTDOWN PROCEDURE

1. Place Well W and Z H/O/A switches in the "**OFF"** position and follow electrical tag out procedures.

2. If the Raw Water Tank is to be cleaned, de-energize cathodic protection, level controls and close tank inlet and outlet valves before draining.

3. After inspection and/or cleaning, follow Normal Operation steps 1 through 4 above

CHAPTER 3

IRRIGATION SYSTEM

3.1 DESCRIPTION OF OPERATION

The Irrigation system consists of three 500 gpm centrifugal pumps, two air compressors, a 5,000 gallon Hydropneumatic Tank, a chlorinator and various controls. Raw water flows by gravity from the Raw Water Tank to the common suction manifold where it is chlorinated just prior to the pumps. Since it is a demand system, irrigation pump operation depends upon water usage throughout the system. Pumps can be isolated by gate valves on the suction and discharge and are equipped with check valves to prevent backflow.

The Irrigation System Chlorinator is controlled semi-automatically by flowrate. An increase or decrease in flowrate proportionally drives a positioner that drives the chlorinator rack assembly. The operator must fine-tune the chlorinator manually to maintain residuals of 0.8 to 1.2 mg/l.

3.2 DESCRIPTION OF IRRIGATION PUMP CONTROL SCHEME

A. Three separate pressure switches control the primary, secondary and third pump operation. The primary pump operates between 61 and 78 psi, secondary between 59 and 74 psi, and third pump between 57 and 72 psi. A three-position selector switch on the control panel determines which pump is primary, secondary, etc. This feature is convenient for rotation of pump operation during winter months due to low demands and also for maintenance purposes.

3.3 DESCRIPTION OF HYDROPNEUMATIC TANK AIR CONTROLS

A. During normal operation, a small amount of air in the Hydropneumatic Tank is carried off with the water that is discharged and therefore must be replenished. Two Warrick level probes within the Hydropneumatic tank automatically control (Electric Valve) EV-201 when air addition to the pressure vessel is necessary. Whenever the water level reaches the upper probe, EV-201 energizes to admit air at which point Air Compressors AC-201 and 202 will run continuously. As the air level reaches the lower probe, the system is satisfied and EV-201 closes.

B. The Hydropneumatic Tank Control Panel is located adjacent to Panel “B” and has two indicator lights for **Hydropneumatic Tank “Low”** and **EV-201 “Open”Admit Air.**

3.4 IRRIGATION SYSTEM START-UP PROCEDURE

1. Open the 12” Raw Water Tank outlet valve. Open all 6" suction and discharge valves on Irrigation Pumps 201, 202, and 203. Open the 6” Hydropneumatic Tank inlet valve. Open the 8” Electro-pneumatic valve and the 8” Irrigation discharge gate valve by the road. NOTE: If maintenance was performed on motors that may affect motor rotation, be sure to "bump" on momentarily to check for proper rotation first. Changing any two wires on a three-phase motor will change rotation.

2. Confirm prime on all three pumps by opening the 1/2" pump drains and the 1/4" pump discharge valves. Close valves when all air has escaped and only water is discharged.

3. Place each irrigation pump on individually and ascertain prime before placing another pump in operation. The Irrigation pumps are the mechanical seal type and should not drip as do the Potable Pumps.

4. The Irrigation System Chlorinator should be adjusted to approximately 1.2#/day for every 100 gpm of flow. The Hydropneumatic Tank should be approximately two-thirds full of air as observed on the sight tube.

5. Place the Irrigation System Chlorine Analyzer in service and adjust to proper specifications.

3.5 IRRIGATION SYSTEM NORMAL OPERATING PROCEDURE

1. Observe pressure and compare with those described above in Section 3.2.

2. Check the Irrigation Chlorine Residual Analyzer for proper operation daily.

3. **NEVER** close the 6” valve to the Hydropneumatic Tank as pressure control switches would be isolated from system

3.6 IRRIGATION SYSTEM SHUTDOWN PROCEDURE

1. Notify the Contracting Officer’s Representative (COR) and the Housing contractor whenever possible well in advance of securing the Irrigation System.

2. Close the Electro-pneumatic Irrigation System discharge valve.

3. Place the selector switches for P-201, P-202, and P-203 in the **OFF** position.

4. Secure the Chlorine Residual Analyzer by closing the CO2 and sample supply valves

5. Record Irrigation Flow totalizer readings in the logbook if power is to be secured.

6. Follow "Lock Out and Tag Procedures" for equipment as necessary when maintenance is to be performed. Individual equipment may be isolated from the system for maintenance when possible.

CHAPTER 4

ELECTRODIALYSIS REVERSAL SYSTEM

4.1 DESCRIPTION OF OPERATION

The EDR Units receive their feed water from Off-Spec (OSPR) Tank TK-102 that is gravity fed from the Raw Water Tank (TK-101). In addition, during polarity reversals, Off-Spec product water from the EDR units is recycled back to the Off-Spec Tank to increase overall unit recovery. Level Valves LV-102 and LV-103 are pneumatically operated valves that work in parallel to maintain the Off-Spec tank level. Level probes within the Off-Spec Tank control the open/close function of both valves. Air Compressors AC-201 and AC-202 supply Air Dryer AD-201 in delivering a source of dry regulated instrument air to both valves.

Upon start-up, Motor-Operated Valve (MOV-1) opens to admit feed water to each unit. As MOV-1 opens fully, the Dilute Feed and Brine pumps are energized. The Dilute Feed Pump discharge is pressure regulated to around 70 psi using a Roll Seal Valve and Pressure Regulator PRV-1. After passing through a 22-element 5-micron filter cartridge vessel, the feed water splits off into two different flow paths as Dilute Feed and Brine Make-up. The 230-gpm Dilute Feed flow eventually becomes unit product after passing through 3 stages of stacks. The Brine Pump re-circulates the concentrate in a loop through the stacks and back again. This brine loop has a constant 43 gpm of “makeup” water (for dilution) and an equivalent amount of “blow down” that is metered by an electromagnetic flowmeter FT-131D as it discharges to the brine pond. Three-way motor-operated valves determine the flow paths of the brine and dilute streams as they enter and exit the membrane stacks. During polarity reversal (every 15 minutes), MOV’s 2, 3, 4, and 5 reverse product and brine flow paths. The reversal process extends unit runtime between cleanings by utilizing both sides of the membrane surface. As dilute and brine enter the EDR membrane stacks, over 400 volts of direct current is applied across the stack using electrodes at the top and bottom. The cations (Na+, Ca++, Mg++) are attracted to the cathode or negative electrode and the anions (Cl-, SO4, HCO3) are attracted to the anode or positive electrode. The cation membranes in the stack allow passage of cations through the membrane but does not allow anions to pass through. Likewise, the anion membrane allows only the anions to migrate through the membrane. The result is a concentration of ions in one flow path (brine) while the dilute flow path becomes demineralized (product).

The electrodes in the EDR membrane stacks have separate cells that are continuously flushed to remove electrolysis reaction products. Such products include chlorine, hydrogen, and oxygen. The electrode waste flow can be visually monitored through variable area flowmeters before being combined into a common 1” drain line that empties into the Brine Pond. During normal operation, three-way valves bypass the corrosive waste around the flowmeters to prevent them from destruction. The Electrode Clean In Place or ECIP equipment, automatically pumps acid into the electrode streams at a rate of 1 quart every 6 hours to prevent scale formation.

Product water from the two EDR units is combined into a common 6" line and chemically treated at injection points prior to entering the Product Tank. A sodium-based linear polyphosphate with the trade name of Aqua Mag is injected at a rate of 6.3 ppm for distribution system corrosion control. The pH is adjusted to 7.5 (+ or – 0.2) by the addition of soda ash. A flow-through pH meter monitors the Product pH downstream of the chemical injection point. Chlorine solution is injected downstream of electromagnetic flowmeter FT-131B prior to entering the 50,000 gallon Potable Water Storage Tank TK-131. After 1.5 hours of contact time in the Product Tank, one of the two potable pumps delivers the potable water to the system. A second flow-through pH meter continuously monitors the Potable water (or Product Tank effluent) as it is pumped to the system. An electromagnetic flowmeter FT-131A registers the Potable flowrate while pressure transmitter PT-131 monitors distribution system pressure. The water being pumped to the system ultimately fills the two 250,000 gallon remote tanks. Both remote tank levels are monitored using level indicators LI-161 and LI-162 and are recorded on Recorder #4 in the Control Room.

Clean In Place (CIP) equipment is provided for the necessary cleaning and disinfection of the membrane stacks and unit piping. A hydrochloric acid solution is primarily used for this purpose although salt, caustic, or hypochlorite solutions can be used as well. This system consists of a 275 gallon solution tank, piping, and valves. It may be used to clean both units simultaneously or individually as required. The stainless steel brine pumps are used to circulate the cleaning solution throughout each unit. Water production can be resumed following a thorough flushing of the units.

TABLE 4-1
USA YPG MAIN POST WATER TREATMENT PLANT
EDR UNIT OPERATING CONDITIONS

Avg. Feedwater Temperature:		25 C
Dilute Flow per unit:		230 gpm
Brine Make-Up Flow per unit:		43 gpm
Pressure Drop per line:		26 psi
Electrode Flows:		0.6 – 1.0 gpm
Electrode Inlet Pressure:		2 psi < Stack Inlet Pressure
Differential In (neg. cycle):		-10" to -12"
Differential Out (neg. cycle):		-20" to -22"
Avg. Feed Conductivity/TDS:		2284 micromhos/1458 ppm
ECIP Acid Usage		0.25 gallons/6hrs unit operating time
Soda Ash Mixture		200 lbs to 40" Water
Aqua Mag Mixture		17 gallons to 25.6" Water
Potable pH Range		7.5 + or - 0.2
Free Chlorine Residual Limits		0.8 to 1.2 ppm
Desired Aqua Mag Dosage		6.3 mg/l (or 1.5 - 1.9 ppm PO4 residual)
Conductivity Controller Setpoint		375 - 450 umhos (as required)
Potable TDS		< 250 ppm
Stage 1	Volts:	451
	Amps:	17.5
Stage 2	Volts:	403
	Amps:	9.2
Stage 3	Volts:	391
	Amps:	4.7
Avg. Product Conductivity/TDS:		275 micromhos/157 ppm

Production per 24 hr/day	
Total two units	606,240 GPD
Brine Blowdown per 24 hr/day	
Total two units	123,840 GPD
Brine Make-Up per 24 hr/day	
Total two units	123,840 GPD

The preceding specifications are based on the following feed water analysis by Ionics, Feb. 16, 1990.

Sodium	376 ppm	Bicarbonate	194 ppm
Calcium	105 ppm	Sulfate	386 ppm
Magnesium	14 ppm	Chloride	379 ppm
Fluoride	4.3 ppm	pH	7.6

Note: All ppm are reported as the ion.

4.2 EDR SYSTEM GAUGES, CONTROLS AND PROTECTIVE DEVICES

The EDR units are provided with instrumentation to monitor and protect the equipment. Automatic systems may determine if the units are operating properly and will sound an alarm and/or shut down the units if problems arise. Manual systems provide the operator with a visual indication and current status of the equipment.

Dilute Feed and Brine Concentrate pressure switches PS-1 and PS-2 are double acting pressure switches, each with a pair of separately adjustable contacts. One contact is adjusted to react at the lowest acceptable pump discharge pressure (18 psi), the other is adjusted to the highest acceptable pump discharge pressure (56 psi). Should the pump exceed either of these limits during operation due to a pump failure, pipe blockage or break, or loss of feed water or other problem, the pressure switch will signal the unit to shut down.

Differential pressure switch DPS-1 monitors the head loss across the 5-micron filter cartridge vessel. When head loss exceeds 10 psi, the switch activates the filter light on the control panel indicating its time to change out filter elements.

Each unit has a conductivity monitor that displays the product conductivity in microsiemens/cm. A set point dial is used to select the value that will be considered "product". A pair of red and green lights indicates whether the conductivity is higher or lower than set point. The conductivity monitor has alarm contacts that control the three-way product diversion valve MOV-6. This valve either sends water to the Off-Spec Tank if above set point, or to the Product Tank if less than set point.

Five panel-mounted pressure gauges display the operating pressures of the EDR units: Feed Pump Discharge, Cartridge Filter Inlet, Cartridge Filter outlet, Electrode Inlet, and Stack Inlet/outlet.

Two panel-mounted flow meters display the Dilute Flow and the Brine Make-up flow rates.

A panel mounted differential pressure meter indicates the differential of the Dilute Feed and Brine Concentrate streams at the inlet to the stacks and, with a flip of a multi-port valve, the outlet of the stacks.

In the Control Room, an output monitor displays the voltage and amperage of each stack.

4.3 EDR UNIT OPERATING PROCEDURE

Note: The following instructions assume that all unit valves and switches are in the normal shutdown mode prior to start up.

1. The EDR units are started daily to replenish the remote tanks.

2. Chemical tank levels are recorded prior to start-up on the EDR Run Data Sheet.

3. The potable pump is started on the quarter hour so that polarity changes may be referenced to the clock. Turn potable pump P-131 or P-132 on depending on the date. Use P-131 on odd dates and P-132 on even dates to equalize pump wear.

4. Energize the **MAIN DISCONNECT** on both **EDR CONTROL CABINETS** as well as the **POWER** and **RECTIFIER** switches. All other switches should be positioned down. The units will now start automatically when the potable pump draws the Product Tank down to 88%.

5. During the 15 minutes that it takes to draw the Product Tank down to 88%, collect a sample of potable water at the potable pump and perform a laboratory analysis. Potable water quality should fall within the following control limits at all times:

   pH - 7.5 + .2 Cl2 - 0.8 to 1.2 ppm TDS - < 250 ppm PO4 – 1.5 to 1.9 ppm

4. Within the first 10 minutes after the EDR units have started, check flows and pressures to make sure they are close to the following specifications:

PARAMETER	DESIGN	ADJUST
Dilute Feed Flow	230 gpm	Dilute Feed
Brine Make-up Flow	43 gpm	Brine Make-up
Diff. In (neg. cycle)	-10” to –12”	Brine Recirc.
Diff. Out (neg. cycle)	-20” to –22”	Brine Blowdown
Filter Outlet Pressure	70 psi	PRV-1
Electrode Inlet Pressure	2psi < Stack In	PRV-2

Allow the units to stabilize at least 45 minutes before making fine adjustments. Check the electrode flows by manually engaging the proper SOV and turning the three-way valve handles with arrows pointing up. The rotameters should read 0.7 to 1.0 gpm. Electrode flows less than 0.6 gpm indicate possible electrode scaling and/or deterioration and should be noted in the logbook. The operator should ascertain that ECIP pumps have been pumping 1 quart every 6 hours. For additional cleaning instructions see ECIP Pump Operation. **NOTE:** Do not operate the unit if there is an electrode flow below 0.4 gpm or serious stack damage may result. Contact the supervisor immediately.

7. After the units are "On-Spec", verify the soda ash and polyphosphate pump prime by opening the 1/4" bleed valve on each discharge manifold. Vent all air from the line until a steady stream of chemical can be seen pulsing with the pump sound. The Product pH Meter must be monitored to assure that the correct amount of soda ash is being applied to maintain the pH at 7.5 + or – 0.2. Soda ash pump P-114 can be increased or decreased to raise or lower the pH of the product water. Auxiliary soda ash pump P-124 can be used in case of P-114 failure. For one unit operation, simply reduce the soda ash pump setting to achieve a 7.5 pH.

8. The polyphosphate injection rate should be checked daily or every 6 hours of unit operation to assure the correct dosage. A volumetric check is performed by closing the tank valve and drawing from the sight tube only. After the EDR units have been on spec for at least 5 minutes, close the valve on the chemical tank. Find an even mark on the sight tube as a starting point and start the stopwatch. After 1" has been used, stop the watch. Record the draw down rate on the EDR Run Sheet.

9. EDR Unit Data is collected after at least an hour of operation to allow stabilization of flows and pressures. Start by taking negative cycle readings five minutes after coming on spec. Record lower electrode flow readings on the negative cycle and upper electrode flows on the positive cycle (with *only <u>one</u>* SOV energized).

4.4 POTABLE WATER CHLORINATOR

The chlorine feed rate should be checked initially when the units come on line and every 6 hours thereafter by observing the chlorinator rotameter in the chlorine house. The dosage potentiometer (pot) is used to adjust the chlorinators' electric positioner. The feed rate should be approximately 5.6 #/24hrs for 2-unit operation and 2.8 #/24hrs for 1-unit operation. This should give the desired 1.0 ppm residual. The chlorinator positioner is actually affected by two elements: the manual dosage pot and flowrate. As flowrate increases, the electric positioner proportionally opens the chlorinator v-notch to increase the feed rate. The operator utilizes the manual dosage pot to fine-tune the residual to 1 ppm. Make necessary adjustments only while both units are on-spec. The Potable Chlorine Analyzer A-131 continuously monitors the residual of the water discharged to the system. The analyzer's output is recorded on Recorder #3 (R-3) which alarms if residuals are < 0.8 or > 1.2 mg/l. A high or low alarm on R-3 will result in a flashing blue beacon and ringing bell. For details on the Chlorine Residual Analyzer see Chapter 10, Section 10.2 or the Wallace and Tiernan instruction book.

4.5 SODA ASH MIXING INSTRUCTIONS

*** SAFETY EQUIPMENT REQUIRED: Ratchet Headgear, gloves, chemical jacket.**

Chemical tank levels must be monitored frequently during unit operation and chemicals mixed when necessary. Soda ash is mixed at 2" or less as indicated on the sight tube. Close the main tank valve and sight tube, then open the auxiliary tank valve. Note the tank level before adding water. Open the product water fill valve after the units have come "on-spec" to allow plenty of time to fill the tank. When the tank is approximately 2/3`s full, turn on the mixer. Be sure to wear above listed safety equipment and slowly add 200# of soda ash. Add the remaining amount of water to increase the previously noted sight tube level by 40 inches. Allow a minimum of 45 minutes for mixing. Keep a close eye on the auxiliary tank level during this time.

Now open the main tank valve and sight tube. Be ***sure*** to close the auxiliary tank valve after it has completely refilled so that it will be full for the next time soda ash needs mixing.

4.6 POLYPHOSPHATE MIXING INTRUCTIONS

*** SAFETY EQUIPMENT REQUIRED: Face shield chemical gloves**

When the tank in use is around the 2" level, valve in the standby tank (which should be full of chemical) and valve out the tank in need of mixing. Close the sight tube isolation valve. While the units are on spec, add product water to approximately two-thirds the tank height by opening the 1” fill valve at the top of the tank. Position the conical fiberglass reinforced polyethylene (FRP) tank on grating in front of pH meters. Using the chemical transfer pump, fill the tank to the mark that represents 17.01 gallons from a bulk drum of Aqua Mag. Position the Overhead Crane hook directly (***never*** lift at an angle) over conical tank and use controls to lift same well above pH Meters and mixing tanks. Position conical tank above the tank using chain drive for bridge. Reference marks on north bridge rail for alignment over tanks. Now lower tank until two of the three legs can be positioned just inside tank lid. Open drain valve on tank and dispense Aqua Mag into tank. Close valve and remove tank in reverse order. Flush all chemical out of conical tank and transfer pump before storing. Valve in sight tube and add remaining water to achieve a total of 32" of mixed solution. If you started with 2", you should now have 34" in sight tube. Turn chemical mixer on for 5 minutes.

4.7 ELECTRODE FLOWMETERS

The electrode flows for each unit should be monitored initially at start-up and every 6 hours of operation thereafter. Turn the three-way valve handles (arrows upward) and manually engage SOV 1 (if negative polarity) or SOV 2 (if positive polarity). Flowrate will fluctuate but should average between 0.7 and 1.0 gpm. Flows less than this may indicate electrode scaling, SOV failure or adjustment of PRV-2 is necessary. Return valve to the original position (arrows down) to protect flowmeters from the corrosive electrode waste water and disengage the SOV.

A flowrate of 0.6 gpm or less should be noted in the operator log and monitored closely. ***__***NEVER***__ operate the unit if an electrode flow is less than 0.4 gpm.

4.8 ECIP PUMP OPERATION

Each unit has a timer operated Electrode Clean In Place (ECIP) pump that injects muriatic acid into the electrode streams every 6 hours of operation. For a 22-minute period, approximately 1 quart of acid is used for electrode cleaning. The purpose is to remove scale that has deposited on the electrodes during operation. The ECIP pumps should be checked while they are in operation to verify prime. Indicator lights on the Control Cabinets indicate pumps in operation. Observe daily usage on the EDR Run Sheets to determine if adjustments need to be made. If the average usage is consistently high or low over several days, adjust the pump speed control and record your adjustment in the log book. The ECIP acid tanks are calibrated in 1/10th inch increments adjacent to the sight tubes. Located in each unit's Control Cabinet is an ECIP pump timer that may be synchronized by rotating the dial clockwise just before the tripping switch. The timers are also equipped with a manual switch designated "permanent on" for continuous operation in case extra electrode cleaning is desired. This may become necessary when electrode flows are less than 0.6 gpm as evidenced by the flowmeters. NOTE: In severe cases, the lower and upper electrode acid supply valves #15 and #16 may be closed to provide individual cleaning to the upper or lower electrode cells. If additional cleaning is not successful, then a stack overhaul may be required.

4.9 ELECTRODE INLET PRESSURE ADJUSTMENT

The electrode inlet pressure must be kept between 1 and 3 psi less than the stack inlet pressure at all times. Use pressure regulator PRV-2 to adjust the electrode inlet pressure. Make small adjustments and bump the second SOV momentarily while observing inlet pressure response. Do not attempt to adjust while the second SOV is energized as this will affect the adjustment.

4.10 FILTER OUTLET PRESSURE ADJUSTMENT

The Filter Outlet Pressure is adjusted to 70 psi using PRV-1 located on top of the Roll Seal Valve. To adjust PRV-1, loosen the 7/16" locking nut and turn the adjustment screw to achieve 70 psi on the Filter Outlet gauge. Flows and differentials will require adjustment following this procedure.

4.11 CONDUCTIVITY SETPOINT CONTROLLERS

Each unit has a conductivity set-point controller that continuously monitors the product stream of each unit prior to the three-way product diversion valve (MOV-6). The function of the controller is to determine the product water conductivity with respect to set-point and control MOV-6. MOV-6 diverts water to the Off-Spec Tank (if above set-point) or the Product Tank (below set-point). The range of this instrument is 0 - 500 microsiemens/cm (or micromhos/cm). The set-point is kept between 375 and 450 microsiemens/cm depending on the feedwater conductivity.

4.12 EDR SHUTDOWN PROCEDURE

When the remote tanks are full, turn the potable pump off and allow the units to top off the product tank. The units will automatically shut off and go into the flush mode. Depending on the sequence timer position at the time of shutdown, it may take up to 30 minutes for the flush to occur. At that time, the amber flushing light will change to red and the units will flush for approximately 4 minutes. **NOTE: If a short flush is observed, the units should be re-started for roughly 5 minutes in manual without the rectifiers on and allowed to flush completely. An incomplete flush can cause rectifier fuses to blow at start-up if all the brine isn't flushed from the stacks.**

When both lights are out, the flush is complete. Record chemical tank levels, totalizers, and time of shutdown on the EDR Run Data Sheet and perform calculations. Secure the following switches on both units: POWER, RECTIFIER, and CONTROL CABINET MAIN DISCONNECTS. Open the stack wetdown valve for 45 seconds to wet stacks.

4.13 BRINE POND OPERATION

Concentrated brine and electrode waste from the EDR units is discharged into the brine pond where a small amount of precipitation of chemical compounds occurs. The supernatant overflows into the sanitary sewer system after 24 hours of detention time. The overflow pipe is screened to prevent trash from entering the sewer system and must be cleaned regularly. The pond also serves to neutralize the acidic waste discharged into it during a CIP flushing procedure.

Every three years, sludge removal is required to control plant and algae growth. Sludge build-up is normally less than 2 inches a year. The present method for sludge removal is to dry it and remove it manually. The following procedures have been found effective for the removal of sludge buildup.

4.13.1 BRINE POND CLEANING PROCEDURE

1. Perform a CIP procedure on the EDR units before draining the pond.

2. Divert the brine and electrode wastes directly to drain by using the three-way valves provided.

3. Set up a spare acid pump to inject a 50% hydrochloric acid in water solution at a rate of 2.5 gallons per day into the injector located on the brine drain line. Plug the acid pump into the acid pump receptacle on Unit 110's electrical raceway. Energize the "Acid Pump" switch on Unit 110's Control Panel for automatic operation.

4. Open the brine pond drain valve 2 full turns initially. As the level decreases, the valve may be opened more. A sump pump may be used to drain the remaining water below the drain level.

5. Allow the sludge to dry sufficiently before shoveling into piles. A BOBCAT can be driven into the pond down the double lined access ramp. Use care not to rip the liner. The dried sludge may be disposed of at the YPG Landfill.

6. When all sludge has been removed, close the pond drain valve and return the brine and electrode waste three-way valves back to their original positions. Discontinue the acid injection pump and flush all equipment with fresh water. Turn Unit 110's Acid Pump switch off.

4.14 EDR UNIT CLEAN IN PLACE PROCEDURE (CIP)

A "Clean in Place" (or CIP) procedure is performed on the EDR units to disinfect and remove calcium carbonate scale that develops over a period of time in the membrane stacks. An acid solution is mixed and circulated through one line of stacks at a time utilizing the Brine Pump on each unit. The Brine Pumps are constructed of stainless steel for this purpose. After cleaning, the units must be flushed to remove the highly conductive acid solution**. NOTE: Incomplete flushing *will* result in blown rectifier fuses!** It is important that the operator not rely on memory and follow each written step in the manual to avoid mistakes that could lead to serious equipment damage and/or operator injury.

4.14.1 SINGLE UNIT CIP PROCEDURE

1. Perform a CIP procedure on the EDR unit following 450 to 500 hours of operating time or when excessive hotspots are present as indicated by stack probing.

2. Flush the CIP solution tank thoroughly with a hose while leaving drain valve #10 open to remove any debris that may be present. Close valve #10 and add water to the black mark representing 150 gallons.

3. Two operators will pump 80 gallons of muriatic acid into the tank as indicated by the second black mark. When pumping acid, proper safety equipment shall be used. This includes acid suit, respirator, gloves, boots, goggles and faceshield. Be sure to flush acid pump with fresh water and neutralize any spills with soda ash.

4. Assure remote tanks are sufficiently filled and units are flushed and secured.

5. The RECTIFIER CABINET disconnect switch on the unit being cleaned should be de-energized and locked out. As always log this information in the Electrical Tag-Out book and record the unit hour meter reading in the CIP record book. The Hand/Off/Auto switch for this same unit shall be turned off and a danger tag affixed to it.

6. Perform the following on the unit being cleaned:

   A. CLOSE valves #1, #2, #3, #11, #12, #13, #14, BRINE BLOWDOWN, OFF-SPEC PRODUCT RECIRC., BRINE MAKE-UP, and DILUTE FEED.
   B. OPEN valves #4, #5, #6, #7, #8, #9 (on CIP tank).
   C. ADJUST the BRINE RECIRC. Valve approximately 1 turn open. (No adjustment is necessary if the unit had previously been at operating specs.)
   D. CLOSE the 3" stack inlet valves on the line that was cleaned first on the previous CIP.
   E. OPEN the 1/4" valve (located near valve #5) long enough to purge all air from the brine pump suction line.

7. With the control room door open, energize the CONTROL CABINET and POWER switch. Listen for pump prime by bumping the CIP switch for roughly 5 seconds 2 or 3 times. If you hear the pump spin down slowly, it is not primed. Leave pump off and repeat step E if necessary to purge remaining air from the lines.

8. When prime is confirmed, check the stack inlet gauge and ADJUST the BRINE RECIRC. Valve to achieve stack inlet pressure of 25 psi.

9. Continue for a period of 1 hour occasionally checking and adding water to the CIP tank if necessary.

10. Secure the CIP switch after 1 hour. Valve in the line of stacks previously isolated and valve out the line just cleaned.

11. Energize the CIP switch again and verify stack inlet pressure of 25 psi. Continue for another hour occasionally checking and adding water to the CIP tank.

12. 15 minutes prior to completing the CIP on the other line of stacks, open the electrode flow valves #11, #12, #13, and #14 on the unit being cleaned. This will send CIP solution through the electrode streams for additional cleaning. It will be necessary to add water to the CIP tank with a hose during this time.

13. After time has lapsed, secure the CIP switch and prepare to flush the unit by performing the following valving:

A. CLOSE valve #4, #5, #6, #7, and #8.
B. OPEN valve #1, #2, #3, OFF-SPEC DRAIN, and all stack inlet valves.
C. VERIFY that valves 11 through 14 are also open.
D. ADJUST the BRINE MAKE-UP, BRINE RECIRC., DILUTE FEED, and BRINE BLOWDOWN valves to approximately 1 turn open.
E. CLOSE the CIP tank valve #9 and OPEN valve #10 to drain used acid solution.

14. ENERGIZE the CONTROL CABINET disconnect and POWER switch on the unit to be flushed. Select MANUAL/START to begin flushing. ADJUST the unit to design operating flows and differentials and continue flushing for a period of 2 hours. During the last 20 minutes of the flush, take a pH of the OFF-SPEC product water and verify that the pH is greater than 6.5 on both negative and positive polarities. Log pH results in the operator log. If the pH is okay, select MANUAL/Stop and allow the unit timer to complete the regular post-flush until amber and red lights are out.

15. Now that the unit is flushed, CLOSE the OFF-SPEC DRAIN valve and OPEN the OFF-SPEC PRODUCT RECIRC. VALVE. The product pH will require increased soda ash for approximately 45 minutes after coming on-line following a CIP. Wet the stacks for 2 minutes in order to flush acid from them. Hose any acid off floors and mop up water. Reset the Brine Totalizer and synchronize the ECIP Pump timers. Print new hour meter readings with label gun and affix to hour meters.

4.14.2 TWO UNIT CIP PROCEDURE

1. Perform a CIP on the EDR units following 450 hours of operating time or when excessive hotspots are present as indicated by stack probing.

2. Flush the CIP solution tank thoroughly with a hose while leaving drain valve #10 open to remove any debris that may be present. Close valve #10 and add water to the 150 gallon mark.

3. Two operators will pump two 55-gallon drums of muriatic acid into the CIP tank. When pumping acid, proper safety equipment shall be used. SAFETY EQUIPMENT REQUIRED: GLOVES (LONG-SLEEVE TYPE), BOOTS, TWO-PIECE ACID SUIT WITH HOOD, AND RATCHET HEADGEAR. NOTE: WEAR HOOD OVER HEAD SO THAT IT OVERLAPS FACEMASK AND TIE HOOD STRINGS TO EFFECT A GOOD SEAL AROUND MASK. Flush acid pump with fresh water and neutralize any spills with soda ash.

4. Before commencing with a CIP, the operator assures that the remote tank level is near full and the units are flushed and secured. The RECTIFIER CABINET switches on both units should be de-energized and locked out. Always log this information in the Electrical Tag-Out book and record the hour meter reading in the CIP record book. The Hand/Off/Auto switches for both units should be turned off also and a danger tag affixed to them. Print new hour meter readings with label gun and affix to hour meters.

5. Perform the following valving on both EDR units:

    A. CLOSE valve #1, #2, #3, #11, #12, #13, #14, BRINE BLOWDOWN, OFF-SPEC PRODUCT RECIRC., BRINE MAKE-UP, and DILUTE.

    B. OPEN valve #4, #5, #6, #7, #8, and #9 (on CIP tank).

    C. ADJUST the BRINE RECIRC. valve approximately 1 turn open. (No adjustment is necessary if the units were previously at operating specs.

    D. CLOSE the 3" stack inlet valves on the lines that were cleaned first on the previous CIP.

    E. OPEN the 1/4" valve (located near valve #5) long enough to purge all air from the brine pump suction lines.

5. With the control room door open, ENERGIZE Unit's 110 CONTROL CABINET disconnect and POWER switch. Listen for pump prime by bumping the CIP switch for roughly 5 seconds 2 or 3 times. If you hear the pump spin down slowly, it is not primed. Repeat step "E" above if necessary to purge remaining air from the lines.

NOTE: Failure to prime pump properly will cause seal damage!

7. Once Unit 110 pump prime is confirmed, shut CIP switch off momentarily while following same procedure for Unit 120. When Unit 120's prime is confirmed, then restart Unit 110.

8. Slowly ADJUST the BRINE RECIRC. valve on both units to achieve a stack inlet pressure to 25 psi.

9. Continue for a period of 1 hour occasionally checking and adding water to the CIP tank when necessary.

10. SECURE the CIP switches after 1 hour. VALVE IN the line of stacks previously isolated and VALVE OUT the line of stacks just cleaned. ENERGIZE the CIP switches again and VERIFY stack inlet pressure of 25 psi. Continue for another hour occasionally checking and adding water to the CIP tank.

11. 15 minutes prior to completing the CIP on the second line of stacks, OPEN the electrode flow valves #11, #12, #13, and #14 on both units. This will send CIP solution through the electrode streams for additional cleaning. It will be necessary to add water to the CIP tank with a hose during this time.

12. After time has lapsed, shut water off to the CIP tank. SECURE the CIP switches and prepare to flush by performing the following valving on the units:

    A. CLOSE valve #4, #5, #6, #7, AND #8.

    B. OPEN valve #1, #2, #3, OFF-SPEC DRAIN, and all stack inlet valves.

    C. VERIFY that valves #11 through #14 are also open.

    D. ADJUST the BRINE MAKE-UP, BRINE RECIRC., DILUTE FEED, and BRINE BLOWDOWN valves to approximately 1 turn open.

    E. CLOSE CIP tank valve #9, and OPEN valve #10.

13. Due to restricted drain capabilities, only one EDR unit can be flushed at a time. Check the CIP record book to see which unit should be flushed first. ENERGIZE the CONTROL CABINET disconnect and POWER switches on the unit to be flushed. Now ENERGIZE the MANUAL/START switch to begin flushing. ADJUST the unit to design operating flows and differentials and continue to flush for a period of two hours. During the last 20 minutes of the flush, take a pH of the OFF-SPEC product water and confirm that the pH is greater the 6.5 on both

negative and positive polarities. Log pH results in the operator log. If the pH is okay, select MANUAL/STOP and allow the unit timer to complete the regular post-flush cycle as indicated by both amber and red flushing lights being out.

14. Repeat step 13 above for the other EDR unit at this time. CLOSE the OFF-SPEC DRAIN valve on the unit flushed first and OPEN the OFF-SPEC RECIRC. Valve fully.

15. Now that both units are flushed, CLOSE the OFF-SPEC DRAIN valve and OPEN the OFF-SPEC PRODUCT RECIRC. valve on the second unit flushed. Place the unit HAND/OFF/AUTO switches and CONTROL CABINET selector switches to the AUTO position.

16. Wet the stacks for a minimum of 2 minutes or more to flush acid from them. Hose any acid off of the floors and mop up water. The Product pH will require increased soda ash upon start up following a CIP procedure. A second soda ash pump is required for the first 45 minutes. Reset the Brine totalizers and synchronize the ECIP Pump timers.

4.15 EDR UNIT CARTRIDGE FILTER CHANGEOUT PROCEDURE

A 22-element cartridge filter vessel is located on the feedwater piping to each EDR unit. It functions to remove suspended particles in the feedwater in order to prevent plugging of the membrane stacks. A small amount of silt and silica sand are discharged from the two well pumps when started along with iron deposits that flake off from the inside of steel piping. The filter elements are rated at 5 microns and are designed to protect the small channels inside the stacks from plugging. If these channels become plugged with silica and impede water flow, hotspots will develop that cannot be removed during normal acid cleaning. Stack disassembly is required to repair this type of problem. The following instructions have been designed to avoid such problems.

1. Change the filter elements on the EDR units when the differential is over 10 psi. This is indicated by the FILTER indicator light on the control panel or by observing filter inlet and outlet pressures.

2. After securing the EDR unit CONTROL CABINET disconnect switch, close the 4" butterfly valve on the filter outlet.

3. Now open the two 1" valves on the filter inlet and filter outlet to drain the filter cartridge vessel.

4. Open the 1/4" vent valve and disconnect the 1/4" tubing connections on the lid.

5. Remove the 8 stainless steel nuts holding the lid. Once the vessel is empty, turn the hand crank to elevate the lid.

6. When the lid is high enough, swing it out of the way and hose the sand off of the PVC nuts holding the elements down.

7. Remove the elements and thoroughly rinse the inside of the vessel to remove all sand and debris. Inspect with flashlight.

8. Remove and clean the 0-ring that seals the lid as well as the groove in which it seats. Apply a small amount of silicone grease to the o-ring before re-installing. Clean all grit from the PVC nuts by hosing off in a bucket. A tap and die can be used to clean up threads if necessary.

9. Install 22 new elements into the vessel. **NOTE: Tighten the PVC nuts sufficiently so that the elements cannot be turned easily by hand.**

10. Close the 1" valves on the filter inlet and outlet and fill the vessel with a hose before replacing the lid.

11. OPEN the 4" butterfly valve on the filter outlet side.

12. Start the unit and open the ¼" valve at the top of the vessel to vent air.

13. Adjust PRV-1 Filter Outlet pressure to 70 psi.

14. Log date, unit, and operating hours in Filter Change Out Record book.

4.16 EDR UNIT STACK PERFORMANCE AND DIAGNOSTIC PROCEDURES

Stack performance is monitored in several different ways that help in scheduling maintenance and repairs. In order to diagnose the internal conditions of each stack, electrical readings or "stack probing" is performed monthly or more often if necessary. The results show us where "hotspots' exist and identify electrode deterioration. Stack probe data, along with electrode flowrate and EDR unit data provide a wealth of information about stack performance.

The electrodes themselves are made of platinum and plated with titanium to resist the highly corrosive gases that develop within the cells during the electrodialysis process. The lifespan of the electrodes is dependant on the amount of work that they perform over time. Each of the three stages in the series removes roughly one half of the salinity from the dilute stream feeding it. The first stage receives the raw feedwater, second stage receives the first stage product as it's feedwater, and the third stage receives the second stage product as it's feedwater. The third stage product becomes the overall unit product.

The following example is given:

	Conductivity	Removal
FEEDWATER - 2000 umhos		
FIRST STAGE STACK PRODUCT - 1000 umhos		1000 umhos
SECOND STAGE STACK PRODUCT - 500 umhos		500 umhos
THIRD STAGE STACK PRODUCT - 250 umhos		250 umhos

Since the majority of work (ion removal) is done by the first stage stacks, this stage requires more frequent maintenance than the second and third stages. A complete stack overhaul is necessary when either of the electrode voltages is 15 volts or more and/or electrode flow has dropped off to around .4 to .5 gpm. The "normal" electrode voltage drop is around 1 to 3 volts. As the titanium plating begins to deteriorate, the voltage will climb upward and require more frequent monitoring during high usage periods. Electrode flows may also indicate that the electrode is deteriorating when flows drop off from the normal 0.8 gpm to 0.6 gpm or less. An overhaul of the stack is necessary at this point and should include replacement of both upper and lower electrodes, 2 heavy cation membranes, and 2 heavy spacers. Any hotspots in the membrane stack itself should be repaired at this time also. A "hotspot" is any voltage over 20 volts using the 2" wide spaced probe.

4.16.1 EDR STACK PROBE PROCEDURE

WARNING: A stack probe can only be performed with power applied to the stack. Therefore it is imperative that the person performing the stack probe wear electrical gloves at all times and NEVER touch or lean into the sides of the stacks directly.

Items required: Digital voltmeter, electrical gloves, probe, colored grease pencil, data sheets and clipboard.

1. Open the stack wetdown valve provided for approximately 45 seconds to wet all 12 stacks simultaneously. The stacks must be wet to obtain accurate readings. This can be done with the rectifiers on however, NEVER use a hose to wet the stacks while the rectifiers are energized due to the shock hazard.

2. Remove all narrow stack covers from both units.

3. Probing may be started on either polarity once the unit is on-spec. Begin by slowly running the probe down the left and right side of the 18" wide stack ends. Probe both east and west ends of the stacks. Observe and record all voltages greater than 20 on the data sheet and mark with a colored grease pencil on the stack itself.

4. Repeat this procedure upon polarity reversal.

5. Check the electrode voltage drop by placing one gear on the electrode and the other on the stack roughly 1/4" from the electrode. Check at least 4 or 5 areas along the 18" span of the electrode. A normal electrode in good condition will read between 1 and 5 volts. An electrode voltage drop of 10 - 15 indicate that the electrode life is nearly spent. Electrode flows should be monitored closely when voltages are this high and preparations made for a stack overhaul.

4.16.2 EDR UNIT STACK REPAIR AND OVERHAUL PROCEDURE

As previously noted, a stack overhaul is necessary when the electrode voltage drop is greater than 15 volts and/or electrode flow has dropped off to .4 to .5 gpm. A stack repair may be necessary when a hotspot exceeds 50 volts or when other circumstances exist such as hydraulic leaks. In any case, stack disassembly is required. The following steps are for a complete overhaul however, if any repairs are made, steps that include replacement of certain items may be deleted as required.

1. If possible, it is desirable to CIP the unit before any maintenance is performed.

2. Lock out the MAIN CONTROL CABINET and log in the Electrical Tag-Out Record book. Hang a "Danger" tag on the unit's Hand/Off/Auto switch and turn it to the off position. Wear steel-toed rubber boots during all stack work.

3. Close all four 3" ball valves on the line of stacks being worked on. Unplug the upper and lower electrode cables from the wireway and pull plugs through access hole in stack cover.

4. Remove the 15/16" bolts on all four upper flanges and the 5/8" electrode flow lines into and out of the upper manifold. Put the bolts and gaskets in a bucket. Remove the stack wetdown manifold.

5. Set up the scaffolding in front of the stack and use the 1 13/16" wrench to remove the six nuts holding the upper manifold down. Two men working on opposite sides of the stack shall loosen each nut roughly half a turn in sequence and then remove nuts and washers.

6. Position the overhead crane directly above the eyelet and attach the turnbuckle/screw pin shackle lifting device. The shackle should be on the crane hook and the turnbuckle hook on the eyelet of the stack top. Carefully lift the upper manifold straight up and then lower it to a position where it can be worked on. Remove the top electrode and clamping bars from the top plate. Secure a garden hose over the middle of membranes with enough flow to keep them wet until ready to tear down. This will keep them from drying out and

help prevent them from floating in the membrane tubs during disassembly. Clean the clamping bars using the wire wheel on grinder in shop. Soak the 1/4" stainless bolts in straight muriatic acid for no more than 5 minutes to clean. After rinsing, inspect and replace pitted or stripped bolts with new.

7. Remove the fiberglass channel, PVC shims, and 1 1/4" PVC pipe sleeves on the side of the stack where membranes will be removed. Also remove the three 1" steel tie-down rods after removing the 1 13/16" nuts and washers beneath the stack. Use extreme care not to lean against stack as it could topple at this point.

8. Before breaking down the stack, be sure hands are clean, as membranes should never be handled with dirty or greasy hands. Start with the shallow tub on the dolly first. Remove approximately 1" of membranes at a time turning 180 degrees face down into the tub. Add water to the tub while filling with membranes. Use the deep tub on the dolly next. Finally set the second small tub on two 24" steps for the last of the membranes.

9. During disassembly and assembly, hotspots and other stack problems may be discovered. Stop immediately to repair these areas as soon as they are discovered. Some problems that may be encountered include:

    A. Holes or a tear, especially in the cation membrane as it is relatively brittle. Replace the membrane. Note: Thoroughly rinse pickling solution from the new membranes before installing.

    B. Polarization of the membrane surface is evidenced by roughness or a more obvious scale buildup. Most often this requires membrane replacement. Check the adjacent spacers for defects in gluing, obstructions, and proper configuration. Scrub spacers with brush to remove excess glue if found.

    C. Membranes with a washboard appearance should be replaced. Again, inspect adjacent spacers carefully for defects and replace if necessary.

    D. Occasionally PVC glue and black or white rubber material may be found in the stack. If possible, it should be removed before it causes a problem.

10. Once all of the membranes are into tubs and covered with water, remove the bottom electrode. Clean the surface and insert the four ½" line up bars. Flush debris from the bottom ports using a hose (at full flow) while at the same time opening the 3" stack inlet valves momentarily. Install the new lower electrode, heavy spacer, heavy cation membrane, and clamping bars. Be sure manifold porting is aligned.

11. Keep water running in the center of the membranes as they are being stacked. Stop

occasionally to align the stack by tapping sides and ends of stack with the 1 foot wooden 2" X 4" blocks. Watch for bent tabs on spacers! Use the 4' level every foot or so to assure a good vertical build. Use care not to lean into stack as it is unstable.

11. Once all membranes are stacked, install a new heavy cation and spacer. Replace the tie-down rods, sleeves, fiberglass channel and the shims at this time to help keep the stack from shifting.

12. Inspect and clean the upper manifold surface before installing the new electrode. (On a used electrode, inspect gaskets). Be sure that electrode and manifold porting are aligned before tightening the ¼" stainless bolts on the clamping bars.

13. Remove the line up bars and carefully set the upper plate assembly onto the stack. Fill the stack with water by placing a hose down one of the 2 1/2" flanges on top. Once the stack is full, use the crane to lift the top plate slightly. This will allow the membranes to "float". The stack will easily move now for aligning the upper manifold with the membranes. The 4' level will help in alignment by using it to push the stack in the direction needed. When proper alignment is accomplished, lower the top plate onto the membranes. Torque the six 1 13/16" nuts to 40 ft lbs initially, then follow normal torque procedures in twenty foot-pound increments to a final value of 120 ft lbs.

14. Reassemble all hydraulic lines, open the stack inlet valves, plug electrode cables in, and replace the wet down manifold.

15. Unlock the CONTROL CABINET main disconnect and return the main panel HAND/OFF/AUTO switch to AUTO. With the rectifier switch off, switch the POWER on and select MANUAL/START to hydraulically test the stack. Check for any leaks and verify that electrode flows are within 0.7 to 0.9 gpm. Run unit at least 10 minutes to flush all air from the system before selecting MANUAL/STOP.

TOOLS AND SUPPLIES REQUIRED FOR STACK WORK:

1 13/16" Indestro Wrench	Turnbuckle and screw pin shackle
1 3/4" Wright Wrench	Medium Vise Grips
1 3/4" Torque Wrench	Lithium Grease
3/8" Drive Impact Wrench	4 – 1' X 2" X 4"`s
3/8" X 1/2" Adapter	4' Carpenter Level
1/2" Drive, 15/16" Socket	2 – Packages of 15 Anions
3/8" Drive, 7/16" Impact Socket	1 – Package of 15 Cations
4 - Stainless Alignment Rods	5 - Regular Spacers
2 - Heavy Cation Membranes	1 - Upper Electrode
2 - Heavy Spacers	1 - Lower Electrode

4.17 SINGLE UNIT OPERATING PROCEDURE

1. On certain occasions it may become necessary to operate one EDR unit at a time. Circumstances such as equipment failure, overhaul, or water supply restrictions are the most common reasons for one unit operation. During the summer months, one unit production will normally maintain the remote tank levels.

2. Begin as with two unit operation by starting the potable pump on the quarter hour and energizing the respective unit's MAIN DISCONNECT, POWER and RECTIFIER switches. Collect the potable water sample and perform an analysis as usual.

3. When the unit comes on-spec, reduce soda ash and polyphosphate pump settings to achieve a product pH of 7.4 to 7.6 and a drawdown of 1" in 3 minutes (+ or - 10 seconds). Both stroke and speed adjustments will be required. Check and if necessary adjust the chlorine dosage at this time to an injection rate of 2.8 #/24hrs.

4. Since the potable pump is now pumping at twice the production rate, it will be necessary to cycle the pump off and on manually to avoid running the product tank dry. When the Product Tank drops to around 60%, secure the potable pump. Re-start the pump at around 90%. Repeat this process until the remote tanks are full or circumstances requiring one unit operation have passed. To resume two-unit operation, secure the potable pump and allow the unit to shut down and flush before starting both units together.

CHAPTER 5

LABORATORY PROCEDURES

5.1 GENERAL

Assurance of satisfactory performance of the YPG Water Treatment Plant requires a thorough sampling and testing program. This section details the sampling program and gives instructions on specific tests. Before performing any of the following laboratory procedures, familiarize yourself with lab equipment and chemicals that are used. The chemicals used in some of these tests may be hazardous to the health and safety of the user if inappropriately handled. Please read all MATERIAL SAFETY DATA SHEETS for reagents used in these tests and use appropriate safety equipment.

Testing capability at the facility includes; Total Dissolved Solids, Conductivity, Free Chlorine Residual, Fluoride, pH, Temperature, Total Hardness, Calcium, Alkalinity, Orthophosphate, Lead, Copper, Iron, Zinc, Chloride, Sulfate, Carbon Dioxide, and Dissolved Oxygen. All analyses for reporting requirements of the Arizona Department of Environmental Quality are conducted by Army Health Personnel (Preventive Medicine). Copies of such tests are forwarded by Preventive Medicine to the water plant and remain on file.

5.2 IN-PLANT SAMPLING LOCATIONS AND FREQUENCIES

- **Raw Water Storage Tank** - Collected at the 1/2" sample valve on the raw water line (north of the air dryer). Monthly analysis for: pH, conductivity, TDS, temperature, chlorine, fluoride and dissolved oxygen.

- **EDR Dilute Feed** - Collected from either EDR unit sample tap marked "dilute". **NOTE:** Collect at least 5 minutes after units have been on-spec. Monthly analysis for: pH, conductivity, TDS, temperature, chlorine, fluoride and dissolved oxygen.

- **EDR Product Water** - Collected from 1" sample valve located between pH meters. **NOTE:** Collect at least 5 minutes after units have been on-spec. Monthly analysis for: pH, conductivity, temperature, TDS, hardness, calcium, alkalinity, chlorine, fluoride and dissolved oxygen.

- **EDR Brine Blowdown** - Collected from 1/4" sample valve near common brine flowmeter. **NOTE:** Collect at least 5 minutes after units have been on-spec. Monthly analysis for: pH, conductivity, temperature, TDS, fluoride and dissolved oxygen.

- **Product Storage Tank** - Collected at the discharge of Potable Pumps P-131 or 132 (whichever is on-line). Daily analysis for: pH, conductivity, temperature, TDS, hardness, calcium, alkalinity, chlorine, and orthophosphate. Monthly analysis for: fluoride and dissolved oxygen.

- **Irrigation Water** - Collected from the bypass hose on the Irrigation Chlorine Residual Analyzer. Monthly analysis for pH and chlorine.

NOTE: Thoroughly flush sample lines and rinse sample bottles three times with sample. Always maintain clean glassware, stir magnets and countertops.

5.3 TOTAL HARDNESS

1. Measure 50 mls of sample water and pour into the porcelain casserole.
2. Add 2 mls (approx. 2 droppers full) of H-2 test reagent and 1 level spoon (inside cap) of H-3 indicator.
3. While stirring, titrate with H-1 until end point is reached. Color of solution changes to blue.
4. Multiply ml of titrant used times 20. Example: 1.4 mls X 20 = 28ppm total hardness

5.4 CALCIUM

1. Measure 50 mls of sample water and pour into the porcelain casserole.
2. Add 2 mls (approx. 2 droppers full) of H-6 test reagent and 1 level spoon (inside cap) of H-7 indicator.
3. While stirring, titrate with H-1 until end point is reached. Color of solution changes to purple.
4. Multiply mls of titrant used times 20. Example: 0.9 mls X 20 = 18ppm calcium

5.5 TOTAL ALKALINITY

1. Measure 50 mls of sample water and pour into the porcelain casserole.
2. Add 2 drops of M-indicator.
3. While stirring, titrate with S0226 until end point is reached. Color of solution changes to pink. Multiply mls of titrant used times 20. Example: 3.4 mls X 20 = 68ppm alkalinity

5.6 CONDUCTIVITY

1. Rinse cell cup three times with sample to be tested, then fill with sample to well above upper electrode.
2. Select range, push black button to read directly in microsiemens/cm of conductivity.
3. Read conductivity on the lowest range possible. If the display blanks out, this indicates an overrange. Turn the range knob one position clockwise.

5.6.1 CONDUCTIVITY METER CALIBRATION

1. Select 2000uS range, remove bottom cover of meter.
2. Rinse the cell cup three times with 442-150 standard solution.
3. Fill with standard solution.
4. Press and hold the black button.
5. Adjust the calibration control inside the meter until the reading is 229uS. Discard the used solution.
6. Replace the bottom cover.

5.7 TOTAL DISSOLVED SOLIDS (TDS)

1. Rinse cell cup three times with sample to be tested, then fill with sample to well above upper electrode.
2. Select range, push black button to read directly in parts per million of TDS.
3. Read TDS on the lowest range possible. If the display blanks out, this indicates and overrange. Turn the range knob one position clockwise.

5.7.1 TOTAL DISSOLVED SOLIDS METER CALIBRATION

1. Select 200uS range, remove bottom cover of meter.
2. Rinse the cell cup three times with 442-150 standard solution.
3. Fill with standard solution.
4. Press and hold the black button.
5. Adjust the calibration control inside the meter until the reading is 150uS. Discard the used solution.
6. Replace the bottom cover.

5.8 CHLORINE RESIDUAL TEST (DPD METHOD)

1. Pour 5 ml sample into viewing tube.
2. Add one packet of Chlorine Free-DPD reagent and swirl gently.
3. Insert the tube into the color comparator and, holding the comparator up to a white background, view through the openings in front.
4. Rotate the color disc to obtain a color match. Read the chlorine residual, in mg/L, from the scale window.

5.9 PHOSPHATE TEST

1. Fill the viewing tube from the ORTHOPHOSPHATE TEST KIT to the 5 mL mark with the sample water.

2. Open one Phosphate Reagent packet and add to the tube. Swirl to mix. Allow at least 1 minute but no longer than 5 minutes for color development. A blue-violet color will develop when phosphate is present.
3. Insert the viewing tube into the color comparator and, holding the comparator up to a white background, view through the openings in the front.
4. Rotate the disc to obtain a color match. Divide the reading in the scale window by 10 to obtain the mg/L phosphate (PO4).

5.10 pH METER CALIBRATION

1. Prepare 4.0 and 7.0 standard buffers in the appropriate 150 mL beakers using the small stir bars.
2. Select pH MODE, Std FUNCTION,and #1 ELECTRODE on the Ionanalyzer.

3. Rinse electrodes with distilled water and blot dry with tissue. Insert probes into 4.0 buffer with mixer set at 4.5.
4. When "READY" is displayed, press "ENTER". The meter will enter the correct value and the display will change to STD 2.
5. Rinse electrodes with distilled water again and blot dry. Insert into 7.0 buffer with mixer set at 4.5.
6. When "READY" is displayed, press "ENTER". The meter will enter the correct value again. Rinse the electrodes and insert into fresh storage solution or perform a pH analysis.
7. Use the FUNCTION key to find the "SLOPE" and record this value in the left side of the logbook.
8. Dispose of the 4.0 buffer but save the 7.0 buffer in the bottle marked electrode storage solution.

5.10.1 pH ANALYSIS

1. Remove the probes from the storage solution and rinse with distilled water over an empty beaker.
2. Use a large stir bar in a separate beaker and rinse with the sample water then fill beaker with sample water.
3. Set mixer to 4.5 and insert probes in beaker. Once "READY" is displayed, record the pH value and temperature.
4. Rinse probes with distilled water again and return them to storage solution.

5.11 FLUORIDE METER CALIBRATION

1. Prepare two appropriate fluoride standards in separate 150 mL beakers with the small stir bars.
2. Select #2 ELECTRODE, Concentration MODE, and Std FUNCTION on Ionanalyzer.
3. Rinse fluoride electrodes with distilled water and blot dry with tissue. Insert the electrodes into the first standard with the mixer set at 4.5.

4. When "READY" is displayed, adjust display to correct reading, using UP or DOWN keys. Press "ENTER" and display will change to Std 2.
5. Rinse electrodes with distilled water and blot dry. Insert electrodes into second standard with the mixer set at 4.5.
6. When "READY" is displayed, adjust display to correct reading, using UP or DOWN keys. Press "ENTER" and perform a fluoride analysis.
7. Dispose of standards. Never pour any used standard back into container.

5.11.1 FLUORIDE ANALYSIS

1. Measure 50 mL of sample water and pour into 150 mL beaker with a small stir bar.
2. Add 50 mL of TISAB reagent to sample.
3. Set Ionanalyzer display to Concentration MODE and #2 ELECTRODE.
4. Rinse electrodes and blot dry. Insert into sample with mixer set at 4.5.
5. When "READY" is displayed, record reading.
6. Return meter to pH MODE and #1 ELECTRODE.

CHAPTER 6

WATER TREATMENT PLANT PREVENTIVE MAINTENANCE

6.1 GENERAL

The YPG Water Treatment Facility must operate every day of the year. A well organized and executed preventive maintenance program is vital in achieving reliability of the equipment and assures an uninterrupted supply of potable and non-potable water to the consumers. Duplication of plant equipment allows some flexibility when performing maintenance while other situations require scheduled downtime. Whenever possible, coordination with the COR and other contractors is necessary to give prior warning of system outages. Daily, weekly, monthly, quarterly, and annual preventive maintenance is required. Other items require maintenance every 2, 3, and 5 years. Many repairs such as pump maintenance, stack overhauls and painting are performed as required and are not listed in the following preventive maintenance schedule.

This chapter lists maintenance tasks that are considered the minimum requirement to provide efficient operations. Many of the tasks are described in this manual, while others require referral to the manufacturer's manual for specific details.

6.2 DAILY PREVENTIVE MAINTENANCE

1. Check motors in operation for excessive heat, vibration, and noise.

2. Check pump packing for proper drip rates.

3. Blow down the air dryer condensate traps.

4. Check electrode flows every 4 hours and verify ECIP pump operations.

5. Wet stacks after securing units and as necessary thereafter.

6. Check for hydraulic leaks; repair if possible or report.

7. Alternate potable pump operation on even and odd dates.

8. Collect samples and perform lab tests as required.

9. Check the irrigation and potable chlorine analyzers for proper flow, pH, and indication.

10. Blow down the raw water wye strainer and all pump drains.

11. Inspect plant site for cleanliness and unsafe conditions.

12. Check operation and alignment of MOV's 1-6 on the EDR units.

13. Check and replenish electrolyte levels in the Chlorine Leak Detector as required.

14. Check area lighting; repair or report as required.

15. Check safety equipment for cleanliness and good condition.

16. Record Irrigation and Potable water totalizers in the daily log.

17. Record the CO2 cylinder pressure and check that the regulator output is 75 psi.

6.3 WEEKLY PREVENTIVE MAINTENANCE

1. Verify operation of the Chlorine Leak Detector and remote alarm function. Coordinate with the Fire Dept.

2. Check that all equipment grounds are secure.

3. Inspect all tools, ladders, lab equipment, etc. for safe condition.

4. Check emergency showers and eyewash stations.

5. Inspect SCBA for proper pressure and condition.

6. Change lab pH meter storage solution and calibrate.

7. Check alarm panel and all equipment indicator bulbs. Coordinate with Fire Dept.

8. Clean process area floors, chemical tanks, and pumps.

9. Clean the Brine Pond effluent screen.

10. Secure breaker #2 on Panel A to check emergency lighting.

11. Check for leaks on all equipment and repair if possible. If not possible, note on trouble report.

12. Clean bathroom and control room fixtures and mop floors.

13. Clean windows, knock down webs, dust, and polish stainless on drinking fountain/eyewash stations.

14. Check oil level in Air Compressors AC-201 and AC-202.

15. Check chlorine leak detector drip rate - 1 drop every 1 - 10 minutes

16. Check Potable and Product Inline pH meter calibration vs. Lab

17. Perform complete Lab Analysis per the WQDS.

6.4 MONTHLY PREVENTIVE MAINTENANCE

1. Exercise all valves that normally do not get used.

2. Clean air filters on the Rectifier Cabinets, Air Compressors, and Air Conditioner Unit.

3. Check Stack wet downs/drains. Clean stack covers

4. Defrost lab refrigerator and clean appliances.

5. Check TDS and Conductivity Meters with 442-150 Standard.

6. Clean eyewash bottles and refill with fresh distilled water.

7. Overflow the remote tanks for 2 or 3 hours.

8. Perform a stack probe on both EDR units.

9. Place well pumps in hand and overflow the Raw Water tank for 15 minutes.

10. Check the cathodic protection amps, volts, and potential on Raw Water and Product Tanks.

11. Inspect Overhead Crane and nylon slings.

12. Record running amps on the following motors: Unit 110 Feed and Brine Pumps, Unit 120 Feed and Brine Pumps, Irrigation Pumps 201, 202, and 203, Potable Pumps 131 and 132, and Air Compressors AC 201 and AC 202.

13. Record the APS meter reading on the first and last days of the month. Calculate total kilowatt hours used.

14. Record the Irrigation and Potable Water Totalizers on the last day of the month.

15. Calibrate Flouride meter and perform monthly flouride analysis on WQDS.

16. Turn in YPG WTP and R/O monthly reports to COR on 1st of the month.

6.5 QUARTERLY PREVENTIVE MAINTENANCE

1. Lock out and tag Irrigation and Potable Pumps individually. Clean, lube, and inspect same.
2. Lock out and tag the Air Compressors individually. Change oil, check belt tension, lube motors, and degrease same.
3. Clean chemical injectors and chemical tank wye strainers and trenches.
4. Replace stem seals and clean v-notches on both chlorinators. Verify vacuum regulator operation

6.6 ANNUAL PREVENTIVE MAINTENANCE

1. Service the Chlorine Leak Detector.

2. Service the Irrigation and Potable Chlorine Positioners.

3. Overhaul Process Area evaporative cooler

4. Replace both 4' flexible connectors on the Chlorine cylinder supply.

5. Service all 12 motor-operated valves on the EDR units.

6. Calibrate level indicators on Remote Tanks A & B, Raw Water Tank, Off-Spec Tank, and Product Tank.

7. Inspect interior surfaces of remote Tanks A & B, Raw Water Tank, and Product Tank.

8. Inspect all high and low voltage electrical connections and tighten wire termination points.

9. Inspect Irrigation Pumps P-201, P-202, and P-203 couplings and alignment.

10. Inspect Potable Pumps P-131 and P-132 coupling alignment.

11. Lubricate Unit 110 and 120 Feed and Brine Pump motors.

12. Calibrate all flowmeters and differential pressure meters.

13. Calibrate all pressure gauges and pressure switches.

14. Inventory Hazardous Chemicals and mail copy to Safety.

15. Clean the Air Dryer condenser coils and inspect unit.

16. Inspect and replace worn ground rods on both EDR units.

17. Clean and inspect all three-phase motor contactors.

18. Rebuild the reference cell and replace the pH electrode on both the Potable and Product Inline pH Meters.

6.7 PREVENTIVE MAINTENANCE EVERY TWO YEARS

1. Replace the 5/8" polyethylene tubing on the Irrigation and Potable Chlorinators.

2. Rebuild the Potable and Irrigation Chlorinators

3. Rebuild the Potable and Irrigation Vacuum Regulator Check Units

6.8 PREVENTIVE MAINTENANCE EVERY THREE YEARS

1. Dry and remove sludge from Brine Pond.

6.9 PREVENTIVE MAINTENANCE EVERY FIVE YEARS

1. Have the SCBA cylinders Hydrostatically tested.

CHAPTER 7

PLANT STAFFING

7.1 GENERAL

YPG Water Treatment Plant operates a minimum of ten hours a day, seven days a week. Many times two men are required to perform certain types of maintenance tasks such as stack overhauls, acid mixing, chlorinator repair, etc;. Although the plant is provided with automatic control devices, routine operational attention and response to maintenance problems must be addressed promptly to assure an uninterrupted supply of water. It is also imperative that the plant be staffed with personnel trained in the various aspects of the plant's operations to answer these operational and maintenance requirements as they arise. This chapter addresses the type of individual skills, examples of duties, training, experience, general knowledge, and physical demands that are required.

7.2 DESCRIPTION OF FACILITY MANAGER/OPERATOR

The Facility Manager/Operator performs any combination of the following tasks as are pertinent to controlling the operations and maintenance of the plant:

A. Operates EDR equipment, mixes chemicals and performs routine and special laboratory analysis and tests. Performs all aspects of an operator to control flow and processing of raw water, brine and product. Monitors gauges, meters and control panels. Maintains shift log and records meter and gauge readings. Performs general custodial duties. Observes variations in operating conditions and interprets meter readings and test results in order to determine processing requirements.

B. Performs electrical and electronic repairs as required. Calibrates gauges, meters, time delays and pressure switches to within specifications. Performs routine maintenance such as pump repairs and stack overhauls. Supervises and/or conducts emergency repairs promptly.

C. Supervises the operation of the plant. Supervises, instructs and assigns specific duties to operations staff. Conducts training of new operators. Maintains an informative and site specific safety program to instruct operators of the inherent dangers associated with the job. Inspects the plant equipment and processes regularly. Analyzes instrument readings and laboratory test results. Maintains and evaluates operations records. Communicates with other plant operators regarding plant conditions. Handles public relations with genuine concern and professionalism.

D. Performs administrative functions such as procurement of all supplies, materials and equipment. Maintains all materials and equipment inventories. Prepares monthly, quarterly and annual reports. Prepares and maintains all personnel records.

7.3.1 QUALIFICATIONS

A. Formal Education: High school graduate or equivalent training and experience. Knowledge of chemistry, science and mechanical subjects are desirable.

B. General Requirements:

1. Knowledge of the process and equipment involved in water treatment.
2. Ability to direct and evaluate operation of the plant.
3. Ability to react promptly and efficiently to emergencies.
4. Ability to perform all required duties.
5. Ability to maintain working relationship with other plant operators.
6. Ability to effectively handle various public relation situations with individuals concerned with their water.

C. Special Requirements:

1. Thorough knowledge of IBM compatible personal computer and proficiency in use and operation of database management, spreadsheet, and word processing software.

D. General Educational Development:

Reasoning:

(a) Apply knowledge of water treatment to solve practical problems.

(b) Interpret a variety of written and oral instructions.

2. Mathematical: Perform ordinary arithmetic, algebraic, and geometric procedures in standard and practical applications.

3. Language:

(a) Establish and maintain communications with superiors and employees, including training and operating instructions.

(b) Prepare and/or revise operational reports, O & M Manuals and other material as required.

(c) Interpret technical manuals, drawings, specifications, blueprints and layouts.

4. Specific Vocation Preparation:

   (a) Completion of Operator Training Course or equivalent training and experience.

   (b) Minimum of three years in water treatment plant operation and maintenance supervision.

   (c) Certified Water Treatment Plant Operator (Class 4) in accordance with the State of Arizona requirements.

5. Aptitudes - Relative to General Working Population (middle third comparison):

   (a) Intelligence.

   (b) Verbal communication skill.

   (c) Numerical comprehension.

   (d) Spatial interpretation ability.

   (e) Form perception ability.

   (f) Clerical perception ability.

   (g) Motor coordination skills.

   (h) Finger dexterity.

   (i) Manual dexterity.

   (j) Eye-hand-foot coordination.

   (k) Color discrimination and perception ability.

6. Interests: Prefer activities involving varied activities of a routine, concrete, organized nature.

7. Temperament: Worker must be able to adjust to situations involving the direction and planning of activities of self and others.

8. Physical Demands: Medium work involving walking, climbing, balancing, stooping, kneeling, crouching, reaching, handling, fingering, talking, hearing, visual acuity, depth perception and color vision. Ability to lift a minimum of 50# above shoulder height.

7.4 DESCRIPTION OF OPERATOR/MECHANIC

The Operator/Mechanic performs any combination of the following tasks as are pertinent to controlling the operations of the plant:

A. Performs all aspects of an operator to control flow and processing of raw water, brine and product. Monitors gauges, meters and control panels. Observes variations in operating conditions and interprets meter readings and test results in order to determine processing requirements. Operates EDR equipment, mixes chemicals and performs routine and special laboratory analysis and tests. Maintains shift log and records meter and gauge readings. Performs general custodial duties.

B. Performs routine maintenance as well as assists in emergency repairs. Inspects plant equipment and processes regularly. Analyses instrument readings and laboratory test results and reports discrepancies to supervisor. Communicates with other plant operators regarding plant conditions.

C. Assists in compiling and inputting computer data for reports, inventories, and plant performance.

7.4.1 QUALIFICATIONS

A. Formal Education: High school graduate or equivalent training and experience. Chemistry, science and mechanical subjects desirable.

B. General Requirements:

1. Knowledge of process and equipment involved in water treatment.

2. Ability to work shift work by oneself without supervision.

3. Ability to react promptly and efficiently to emergencies.

4. Ability to perform all required duties.

5. Ability to maintain working relationship with other plant operators.

C. General Educational Development:

1. Reasoning:

   (a) Apply knowledge of water treatment to solve practical problems.

   (b) Interpret a variety of written and oral instructions.

2. Mathematical: Perform ordinary arithmetic, algebraic, and geometric procedures in standard and practical applications.

3. Language:

   (a) Establish and maintain communications with superiors and fellow employees, including training and operating instructions.

   (b) Assist in the preparation of various operating reports, as required.

4. Specific Vocation Preparation:

   (a) Completion of Operator Training Course or equivalent training and experience.

   (b) One to three years in water treatment plant operation depending upon worker's related experience and training.

   (c) Certified Water Treatment Plant Operator (Grade 1) in accordance with the State of Arizona requirements.

5. Aptitudes - Relative to General Working Population (middle third comparison):
   (a) Intelligence.

   (b) Verbal communication skill.

   (c) Numerical comprehension.

   (d) Spatial interpretation ability.

   (e) Form perception ability.

   (f) Clerical perception ability.

   (g) Motor coordination skills.

(g) Finger dexterity.

(i) Manual dexterity.

(j) Eye-hand-foot coordination.

(k) Color discrimination and perception ability.

6. Interests: Prefer activities involving varied activities of a routine, concrete, organized nature.

7. Temperament: Worker must be able to adjust to
situations involving the direction and planning of activities of self and others.

8. Physical Demands: Medium work involving walking, climbing, balancing, stooping, kneeling, crouching, reaching, handling, fingering, talking, hearing, visual acuity, depth perception and color vision. Ability to lift a minimum of 50# above shoulder height.

CHAPTER 8

RECORD KEEPING

8.1 GENERAL

Accurate record keeping is important to the plant operation for a variety of reasons. System performance can be evaluated and adjusted to maintain efficiency. Maintenance schedules can be adapted to achieve maximum life of the equipment. In many cases, costs can be saved in parts, downtime and labor hours when careful evaluation is practiced. Control of inventories assures availability of crucial items. Results of certain studies give comparisons of various chemicals and concentrations used to prevent system corrosion. Other records may help justify the expansion or modification of a system. Historical records can simply be interesting and informative to the Operator and visitors to the plant.

8.2 OPERATIONS RECORDS

Examples of the EDR Run Data Sheet, EDR Unit Stack Probe Data Sheet, Water Quality Data Sheet, and Laboratory Analysis Data Sheets are provided on the following pages. The EDR Run Data Sheet provides a daily record of the EDR units' electrical and hydraulic data, chemical dosages, in addition to potable and brine water production statistics. The EDR Unit Stack Probe Data Sheet provides voltage data on each stack to identify and keep track of problem areas that may exist within the stack internally. The Lab Analysis Data Sheet provides a running record of all lab analyses performed. The Water Quality Data Sheet provides a daily record of raw, irrigation, dilute feed, brine, EDR product, and potable water analyses.

8.3 MAINTENANCE RECORDS

Examples of the Daily, Weekly, Monthly and Annual Preventive Maintenance Schedules are provided on the following pages. These forms serve as records of the preventive maintenance performed and whether or not problems may have been encountered.

Also included are; CIP Record, Filter Change Out Record, Trouble Report, Pressure and Flowmeter Calibration Record Sheets.

8.4 INVENTORY RECORDS

Provided in Appendices D, E and F are Government Furnished Equipment, Expendable Supplies and Chemical Inventory lists. Government Furnished Equipment is inventoried semi-annually whereas Expendable Supplies and Chemicals are inventoried quarterly. Database files used for these inventories are kept updated with current information. Copies of inventories are forwarded to Contract Administrator Linda Renteria of Contracting.

CHAPTER 9

SAFETY

9.1 GENERAL

The Plant Manager shall insist on employees observing and obeying every rule, regulation and order, as is necessary for the safe conduct of the work, and shall take such action as is necessary to obtain observance.

All employees shall be given frequent accident prevention instructions. In addition, all employees shall render every possible aid to safe operations, and report all unsafe conditions or practices to the proper authority.

Further detailed safety information is provided in Safety Practice for Water Utilities (M3), published by the AWWA.

9.2 SAFETY RULES AND GUIDELINES

For safe working conditions, employees shall observe the following rules of conduct and procedures:

1. Do not allow anyone on the job that is known to be under the influence of drugs, including alcohol.

2. Horseplay, scuffling, and other acts which tend to have an adverse influence on the safety or well being of any employees shall be prohibited.

3. Work shall be well planned and supervised to forestall injuries in the handling of heavy materials and in working with equipment.

4. No one shall knowingly be permitted or required to work while his ability or alertness is so impaired by fatigue, illness, or other causes that might unnecessarily expose him or others to injury.

5. Employees shall not enter manholes, chambers, tanks or other similar places unless there is continuous monitoring equipment such as O2, toxic gases or explosivity meters.

6. Employees shall be alert to see that all safety guards and other protective devices are in proper places and adjusted, and shall report deficiencies promptly to the supervisor.

7. Workers shall not handle or tamper with any electrical equipment, machinery, or air or water lines in a manner not within the scope of their duties, unless they have received specific instructions from their supervisor.

8. All injuries shall be reported promptly to the Plant Manager so that arrangements can be made for medical or First Aid treatment

9. For any job-related injury requiring a visit to a physician, obtain a physician's release before returning to the job.

10. When lifting heavy objects, use the large muscles of the legs instead of the smaller muscles of the back.

11. All employees shall wear work shoes with slip resistant soles. Shoes with thin or badly worn soles shall not be worn.

12. Do not throw material, tools, or other objects from buildings or structures until proper precautions are taken to protect others from the hazards of falling objects.

13. Wash thoroughly after handling injurious or poisonous substances and follow all special instructions from authorized sources regarding this matter. Always clean hands thoroughly just prior to eating. Work at this water plant entails handling reagents, chemicals, raw water, paint or similar potentially toxic substances.

14. While climbing ladders, face the ladder and use both hands.

15. Do not use gasoline for cleaning purposes.

16. No burning, welding, or other source of ignition shall be applied to any enclosed tank or vessel, even if there are some openings, until it has been determined that no possibility of explosion exists. Authority for the work must be obtained from the immediate supervisor and the YPG Fire Department as applicable.

17. Promptly report to the supervisor any damage to stairs, scaffold, false work, or other supporting structures.

18. Hard hats must be worn at all times outside of the plant yard and in the plant yard where danger of falling objects or other injury is apparent.

19. Keep faces of hammers in good condition to avoid flying nails and bruised fingers.

20. Hold chisels in such a way that the knuckles will be protected.

21. Do not use pipe or Stillson wrenches as a substitute for other wrenches.

22. Do not alter wrenches by the addition of handle extensions or cheaters.

23. Keep handsaws sharp.

24. Use only those files equipped with handles. Never use a file as a punch or pry.

25. Do not use a file as a chisel.

26. Do not push wheelbarrow with handles in an upright position.

27. Do not lift or lower portable electric tools by means of the power cord. Use a rope.

28. Do not leave the cords of portable electric tools where cars or trucks can run over them.

29. In locations where handling of a portable power tool is difficult, such as high places. Suspend it from some stable object by means of a rope or similar support of adequate strength.

30. Eye shields shall be worn when working in areas of eye hazard, such as power saws, lathes, jack hammers, grinders, chemical handling, etc. Clean shields after using.

31. Do not attempt to operate machinery or equipment without special permission, unless it is a regular duty.

32. Do not wear loose or frayed clothing, such as dangling ties, around moving machinery or other sources of entanglement.

33. Do not repair or adjust machinery while it is in operation, nor attempt to oil moving parts, except on equipment that is designed or fitted with safeguards to protect the person performing the work.

34. Do not work under vehicles or objects that are supported by jacks or chain hoists without protective blocking that will prevent injury if jacks or hoists fail.

35. Do not disconnect air hoses at compressors until hose lines have been bled.

36. Be sure no one is below before operating excavating equipment near tops of cuts, banks, and cliffs.

37. Employees shall wear proper footwear while working. Proper footwear shall be worn to protect the individual under varying circumstances. Boots shall be worn in wet area and reinforced shoes must be worn in areas where there may be falling objects. All shoes shall be constructed of heavy-duty material. Footwear, which is defective or not appropriate to the extent that its ordinary use creates the possibility of foot injuries, shall not be worn.

38. Observe "NO SMOKING" signs. Remember hazardous gases are produced and emitted in various areas around the plant.

39. Always throw and lock the main breaker of the section to be worked on. Log this information, along with the reason, in the Electrical Tag-Out Record Book. Check components for power with a voltmeter. After repair, clear personnel from the area BEFORE closing the breaker. There shall be a minimum of two persons on this type of job. Only trained personnel shall attempt the repair.

WHEN WORKING ON ELECTRICALLY DRIVEN EQUIPMENT, REMEMBER:

A) De-energize and lock the circuit breaker.
B) Check and be sure there is no power in the piece of equipment.
C) Clear personnel from area before re-energizing the breaker after repair.

40. One person may perform a stack probe, using the Model "H" D & S style probe, if he/she is trained to do so. Always use lineman gloves and rubber boots for protection.

41. **ALWAYS ADD ACID TO WATER**. Caution must be used when mixing acid with water, it can cause a violent reaction.

42. Two people will be required when working on the acid system as well as transferring acid from carboys to the C.I.P. mixing tank. They must wear acid suits, rubber gloves (tucked into sleeves), safety boots (tucked inside pant legs), and ratchet headgear with built-in respirator. Any spills shall be neutralized with soda ash solution. The portable acid pump shall be thoroughly flushed with fresh water after each use. Rinse all protective gear after using and put away clean and dry.

43. Any work done on the chlorine system will be done with two people. This includes: standard cylinder change outs, maintenance and emergency repair.

(A) For standard cylinder change outs, minimum protection would include gloves, shield and cartridge or canister type respirators.
(B) For maintenance of system, follow proper procedures for evacuating entire system of chlorine gas. Use same protective equipment listed in A) above. Never use acid or chemicals to clean parts. Parts should be rinsed several

times with water before brushing with a mild soapy solution. Parts should be completely dry before reassembly.

(C) Emergency repair should be attempted from an upwind location with two individuals present. Some personal judgement is involved depending on size of leak. After fitting SCBA, rubber suit, boots, and gloves, enter area with caution. If the leak appears small, secure cylinder shut off valve and leave the area until the residual chlorine dissipates. Chlorine is absorbed readily into skin, so the less exposure the better. If it is apparent that the cylinder is leaking, attempt to repair it using the kit provided. A safety man should maintain safe distance and be ready with his own equipment if necessary.

44. Always use the right tool for the job. If it is not available, report it to the supervisor.

45. Listen to equipment for unusual noises and monitor motors for excessive heat and vibration by sense of touch.

46. Mop standing water from concrete surfaces.

47. Report, and if possible, repair any hydraulic leaks that are found.

48. Wipe down all safety equipment after each use. It should be clean and ready for use when needed.

49. Operators shall be aware of the locations and the proper use of fire extinguisher and the locations of emergency exits.

*** Halon Fire Extinguishers (BC)**

a. Process Building - South Door (inside)
b. Process Building - Upstairs Shop/Storage Area

NOTE: For flammable liquids and electrical fires; displaces oxygen; avoid confined spaces; can produce toxic gases; Use self-contained breathing apparatus when necessary. Aim at base of fire; use sweeping motion.

*** Dry Chemical Fire Extinguishers (ABC)**

a. Process Building - West Door (inside)
b. Process Building - North Door (inside)
c. Process Building Apron - North Door (outside)
d. Chemical Storage Bldg. - West Mandoor (inside)

NOTE: For use on all fires; corrosive - clean up immediately after use; can be hard to clean up. Aim at base of fire; use sweeping motion.

50. Personal protection equipment, including safety glasses and aprons shall be worn while conducting lab work involving hazardous chemicals.

51. Operations that release flammable, corrosive, toxic or noxious fumes shall be conducted in a well-ventilated area. Reagent chemicals are normally used in small quantities and by personnel who have been instructed about their hazardous properties. Since nearly all chemicals are hazardous under some circumstances, it is good practice to avoid inhaling or ingesting any

    chemicals and to permit no substance to contact the skin.

52. Always wash down the work area after handling chemicals; never allow chemical spills to remain on the floor for any length of time.

53. Never put any chemical into another container without adequately marking the new container.

54. Quarterly review of Material Safety Data Sheets is required of all employees.

55. Proper protective equipment and extreme caution should be used when disconnecting discharge tubing and piping from chemical injection pumps, as check valves may hold pressure, even when pump is off.

56. Keep a clean, neat and orderly treatment facility. Remove and discard combustibles (leaves, weeds, paper, etc.) from around the plant site.

57. If and when it is required to remove gratings for maintenance, mark the area with bright colored barrier tape to warn unsuspecting visitors of the hazard.

58. Always think things through prior to beginning an unfamiliar job.

9.3 SPECIFIC SAFETY PRECAUTIONS FOR THE YPG WATER PLANT

The Yuma Proving Ground Water Treatment Plant contains various potential hazards similar to those existing in any industrial plant.

Some of the unique hazards associated with a water treatment plant facility are the handling of chlorine and exposure to other chemicals. Caution must be exercised in all activities around the plant by the operations staff; necessary steps should be taken to protect visitors to the plant site from

hazardous situations unknown to them. This section discusses most of the common hazards encountered by the operations staff.

9.3.1 PROTECTIVE DEVICES

Channels are provided with plates or gratings to form walkways. Care should be taken to see that these covers are always in place, and that they have not slipped to one side leaving an edge without support. This situation is very dangerous because the plate may not support the weight of a man. Most mechanical equipment is equipped with coupling guards, belt guards, and other safety devices, which should always be replaced if they are removed for any reason.

9.3.2 SAFE PRACTICES FOR PREVENTION OF BODY INFECTION

The use of First Aid Kits cannot be over-emphasized. Prompt attention to all injuries is important. For all but minor injuries, a doctor should be seen. Instruction in First Aid treatment is available from the State Health Department, National Safety Council, Federal Bureau of Mines, American Red Cross, and the manufacture of First Aid Kits, supplied at the treatment plant.

9.3.3 CHLORINE LEAKS

Chlorine at the Water Treatment Plant is supplied in 150 lb. cylinders. Roughly 88% of the tank contents are liquid and the remainder is gas. Chlorine cylinder pressure increases with higher ambient temperature and therefore should be stored away from heat sources. Chlorine gas is not corrosive to metals unless moisture is present. When water is introduced, chlorine becomes very corrosive to most common metals. Therefore, water should ***never*** be used on leaks because it could cause the leak to become larger. Chlorine is strongly corrosive and extremely toxic in both the gaseous and liquid states. Extreme caution should be exercised to prevent bodily contact with any chlorine gas or solutions. Breathing the gas will cause damage to the respiratory system and in high enough concentrations, death will result. The odor of the chlorine gas is so strong that it is readily detected by smell even in extremely low concentrations. Always remember that since chlorine gas is heavier than air, it will collect in low lying areas.

The chlorine house is equipped with a leak detector that will alarm at levels above 3 ppm. When initiated, the alarm activates a highly audible siren in addition to the RIS Panel located in the Control Room. The RIS Alarm panel in turn sets off both the Monaco and Bailey alarm systems notifying the Fire Department of a leak condition. At the same time, an auto-dialer initiates calls to all operator personnel at home for after-hours notification. During normal daytime hours, there may be only one operator present at the plant. The operator must quickly assess the severity of the leak and take appropriate action. The operator will call the Fire Department to acknowledge that a leak alarm has just occurred. A cordless phone at the plant will allow the operator to stay in touch with Fire Department personnel as he/she ventures out onto the north apron to assess the severity of the

leak. Fire Department personnel will be in route to the plant during this time. If the operator is working alone, he/she must be sure to stay upwind of the chlorine house and approach with extreme caution. Any sign of a greenish gas cloud coming from the Chlorine House indicates a "severe leak" is present and the operator should quickly flee to a safe upwind area while the Fire Department Haz-Mat Team arrives. Although operations staff is trained to use the chlorine cylinder repair kits, the proper full coverage Haz-Mat gear is not available to the operator. Only properly trained Haz-Mat personnel should attempt to repair a "severe leak" exhibited by a greenish cloud. Severe leaks will most likely originate from a point on the cylinder up to the Vacuum Regulator Check Unit (which is mounted on the pressurized manifold). Haz-Mat personnel should make it their first priority to secure the cylinder valve (assuming the leak is after the valve) and vacate the area while the high concentration of chlorine dissipates. If the leak is originating from the actual chlorine cylinder, then the Haz-Mat team should apply the appropriate patch from one of the two on-site Chlorine Cylinder Repair Kits.

Fortunately, over the years, YPG has never encountered a "severe leak". From time to time, small leaks have occurred which are dealt with using a common sense approach. Most small leaks originate on the vacuum side of the system. The two-man rule applies to small leaks as well as large leaks. Always have a backup person close by prior to entering the chlorine house. Small leaks may be detected by cautiously approaching the exhaust vent fan (located on the west wall of the chlorine house) from an upwind location. NOTE: In order to safely deal with a small chlorine leak, be sure to use the self-contained breathing apparatus, chemical gloves and suit. If the odor of chlorine gas is apparent, try to pinpoint the location of the leak by using some ammonia solution on a swab or paper towel (located in cabinet). Move the swab or towel slowly around the chlorinators and various fittings. Ammonia vapor will react with the chlorine leak and appear similar to cigarette smoke. After the leak is identified, secure the cylinder valves and the operator can start the EDR Units in order to draw down the remaining pressure in the supply manifold. Once this is done, operator staff can purge the lines and make necessary repairs to the system.

The following reminders are provided to safely deal with a chlorine leak:

1. **NEVER** enter an affected area without an assistant immediately outside, prepared to come to your assistance. Fire Department personnel have the necessary safety equipment and may act as backup if a second operator is not immediately available. Always use the buddy system!
2. Clear the area of all unnecessary or unprotected personnel.
3. Don self-contained breathing apparatus before entering the affected area. Make sure the mask is always in good working condition and that it is working properly before proceeding. Never use canisters.
4. **CAUTION:** The SCBA has a maximum air supply of 30 minutes. Psychological stress will shorten the time.
5. Get in and out of the affected area as quickly as possible.
6. If possible, isolate the leak by closing the appropriate valves. All personnel must be thoroughly familiar with the chlorine piping.

7. Notify the Fire Department if the leak is “severe” (greenish gas) so that they can dispatch the Haz-Mat team.
8. If skin and eye burns are due to chlorine, flush with fresh water and give the victim clean air to breathe, either with a gas mask or by removal to an unaffected area. Seek immediate medical attention.

For further information regarding the safe use of, and additional properties of chlorine, refer to:

1. AWWA Publication M20 "Water Chlorination Principles and Practices".
2. “Chlorine Manual”, The Chlorine Institute.
3. Pamphlet G-3, Compressed Gas Association.

9.3.4 OXYGEN DEPLETED AND LOW OXYGEN AREAS

Perhaps the greatest hazard to operation and maintenance personnel involves working in an area of low oxygen levels and areas devoid of atmospheric oxygen. This often occurs in confined areas such as manholes, pump stations and tanks of any kind. Unfortunately, an individual often does not realize that oxygen levels are dangerously low until it is too late and the results are often tragic. Therefore, it is most important to follow basic safety rules before entering a confined space.

First, the oxygen level must be determined. This is as important as determining the presence of a combustible vapor. Second, an individual must never enter a confined space unless he is wearing a lifeline and two people
stand ready to offer assistance if the individual should be overcome by gases or oxygen deficiency. The importance of these simple but vital safety rules cannot be over-emphasized.

The following conditions have been observed and should be noted:

A) Methane gas will always be located near the top of sewer manholes and other enclosed structures and the amount present is far less in samples taken at a depth greater than six feet below the surface. In any area where explosive or flammable gases may tend to accumulate, such as manholes or confining structures, an explosimeter should be used to detect such gases prior to entering or working in such areas.

B) Explosive hydrogen gas is generated by the EDR process. Although this gas is vented through the electrode waste discharge line at the brine pond, NO SMOKING AREAS must be strictly observed as a safety precaution.

9.3.5 SAFETY PRECAUTIONS FOR THE EDR UNITS

9.3.5.1 EQUIPMENT SHUT-DOWN EMERGENCY

If an emergency shut-down is required, use the MAIN DISCONNECT BREAKER at the top of the control cabinet to turn off the unit.

This will stop the system completely and immediately. DO NOT use the START/STOP control switch to shutdown in an emergency; the STOP position of the switch activates the flushing cycle, and does not stop the unit immediately.

NORMAL

The unit must be in MANUAL mode to manually shut down the unit. In the AUTOMATIC mode, the units will start and stop on external level control system, and the STOP/START switch will have no control. To stop the system, move the AUTO/MANUAL switch to MANUAL, and then the START/STOP switch to stop. At this point, the unit will enter the post-operating flush cycle, which flushes the units with feed water. The units may enter this cycle immediately, or it may shut down and then restart after a period of time which could be as long as 30 minutes. After the flush is completed, the unit will not restart until a new start signal, is received.

9.3.5.2 GROUNDING

It is very important that the entire Aquamite system, including the stacks, be connected to an electrical ground of earth potential. This is to ensure that any portion of the system with which an operator or other persons may come in contact with cannot cause an electrical shock due to stray voltages. During unit installation, a connection was made by a separate grounding wire attached securely to the skid and connected to earth. In addition, each of the stacks are grounded by a wire connecting the bottom end plate steel to the skid or electrical wireway conduit. Do not allow the ground wires to be removed or to become disconnected. All ground connections will be checked on a weekly basis and must be repaired if necessary.

9.3.5.3 HIGH VOLTAGE

The units use high voltage AC power, and rectify this to DC voltage to operate the membrane stacks.

THESE VOLTAGES CAN CAUSE SEVERE INJURY OR DEATH. Therefore, use extreme care when working around the operating units, especially when the stack protective covers are not in place, or the electrical enclosure doors are open.

Each stack is labeled with a "CAUTION HIGH VOLTAGE" warning sign.

9.3.5.4 THE EDR STACKS

Do not touch the wet stack sides, electrode plates, or their tab connections when the unit is operating. The red stack warning lights show when power is applied to the stacks. Always wear rubber gloves when stack probing is performed. NEVER direct a hose on a stack when DC power is on. If it is necessary to wash down the equipment or stacks, be sure the unit is completely shut off.

9.3.5.5 ELECTRICAL PANELS

All control panels contain live voltage. The panel door has a safety interlock mechanism that is designed so that the main breaker must be shut off before the door can be opened. However, in some cases, troubleshooting requires that these mechanisms be defeated to locate problems while power is applied to the system with the door open. In such cases, extreme care must be exercised so as not to come into contact with electrically live components.

NEVER TROUBLESHOOT the control panel unless you understand the layout of the panel and components inside. Only experienced personnel shall service the equipment.

NEVER OPERATE THE SYSTEM WITH THE POWER PANEL DOORS OPEN, except when it is necessary to do so for repair or trouble shooting purposes. This not only protects persons in the area of the equipment from electrical hazard, but also protects the electrical system from exposure to dust and/or spraying water.

9.3.5.6 MECHANICAL SYSTEMS STACK DISASSEMBLING

When performing stack maintenance, it is necessary to remove the stack top plate by lifting it with the hoist provided. This plate is very heavy. DO NOT WORK BELOW the plate while it is supported. Move it to one side or set it down on a firm surface before proceeding.

9.3.5.7 OPERATION OF PUMPS

Do not operate any centrifugal pump with either discharge or suction valves closed. If a pump is operated without flow passing through it, the friction of the impeller rotating in the trapped volume of water will heat the water to a very high temperature. If this heated water were to escape, it could cause serious burns to anyone coming in contact with it.

Your safety is more important than the equipment; please do not act irresponsibly.

CHAPTER 10

MISCELLANEOUS PROCEDURES

10.1 CARBON DIOXIDE CYLINDER CHANGE PROCEDURE

When the CO2 cylinder is empty, perform the following steps:

1. Gently close the needle valves on the front of the chlorine analyzers to secure the CO2 supply.

2. Secure the main valve on the empty cylinder and remove the regulator. Hang the regulator on the wall bracket adjacent to the cylinder. Place cylinder protective cap back on cylinder before moving the empty cylinder. Replace the empty cylinder with a full cylinder. Using a new gasket, re-install the regulator.

3. With regulator installed, open the main cylinder valve and check for leaks on all of the fittings, using a soap solution.

4. Now open the needle valves approximately 3/4 of a turn. Check for proper pressure of 75 psi on the regulator. Adjust regulator if required.

5. Wait 15 minutes or until there is a stable reading and then check chlorine analyzers for proper flow, pH, and indication.

6. Store empty cylinder by East door with yellow "EMPTY" ring on top.

10.2 CHLORINE RESIDUAL ANALYZERS

To assure proper operation and indication, Potable and Irrigation chlorine residual analyzers should be checked daily for proper flow, pH, and indication.

1. Using the bottle marked "380 mL/min", time the sample cell flowrate with a stopwatch. If the flow is not correct, use a wide blade screw driver to adjust the PVC screw at the back of the analyzer. If the flow is correct, proceed to the next step.

2. Immediately run a pH analysis on the water collected from the sample flow. The pH should be between 5.5 and 5.8. If it is not within this range, adjust the CO2 needle valve at the front of the analyzer. Allow 4 to 5 minutes between adjustments to check the pH. The bubble pattern within the sample cell is a good indicator of the correct CO2 amount. An excessive amount of large bubbles indicates too much CO2 flow. However, an occasional large bubble is acceptable. When the pH is correct, proceed to the next step.

3. Collect a sample from the bypass hose in the back of the analyzer. Note the chlorine analyzer reading at this time. Analyze the sample using the DPD Method. Compare the results of the test to the indication on the analyzer. In case of a discrepancy, use the zero pot on the front of the analyzer to adjust the indication to match the DPD results. Run another comparison to verify the calibration. Never attempt to adjust during periods of fluctuation.

4. Check the sample cell grit for the proper amount. If a small white band of grit is not present, add grit. Sprinkle a small amount of grit into the lid of the container. Remove the PVC cap and light assembly and add contents of the cap into the cell. Excess grit can be removed by removing the lower electrode momentarily.

5. In some cases it may be necessary to secure one or both of the chlorine analyzers; e.g.; irrigation system repairs, extended power outages, etc. Secure the CO2 to the analyzer at the needle valve above the rotameter. Also, secure the 1/2" supply valve on the back of the analyzer.

6. To return the analyzer to service, open the valves in reverse order and allow to stabilize. Repeat the steps above.

10.3 CHLORINE CYLINDER CHANGE PROCEDURE

Two operators are required to perform the following procedures.

1. Secure the main valve on the empty cylinder.

2. Secure the vacuum regulator check unit (counter clockwise to the up position) of cylinder that is in service (full cylinder).

3. With the vacuum regulator of the empty cylinder still in service, a vacuum will be pulled on the system. Red flags will appear in the window next to the rotameter. Make sure the empty cylinders' auxiliary valve is open.

4. With red flags visible, remove the auxiliary valve assembly on the empty cylinder and replace the protective cover over the cylinder valve. Roll the empty cylinder to the cylinder storage area outside of the chlorine room. Place the yellow "EMPTY" ring on top of the cylinder.

5. Place the full cylinder on the scale and install the auxiliary valve assembly. Always use a new lead gasket. Tighten connections without bending flex tubing. Be sure to secure cylinder with chain.

6. Open the new cylinder valve and use the ammonia swab to check for leaks. Leaks can be detected by the appearance of white smoke. If no leaks are detected, place the other full

cylinder back in service. Then, place the new cylinder in standby, turning the vacuum regulator check unit knob down while making sure the screw head is up.

10.4 TIME SET PROCEDURE FOR TAYLOR MOD 30 RECORDERS

1. Plug the P Box into the Recorder. The display on the P Box reads MOD 30 P BOX, and then cycles automatically to TEMPLATE BLOCK.

2. Depress the **NEXT LINE** key two times. The display will now read USER ACCESS=1.

3. Type in **M_S_S** and then **TRANSMIT**. The display now should read USER ACCESS=3.

4. Depress the **NEXT LINE** key. The display will read
   ACTIVITY=READ

5. Type **T**, and then **TRANSMIT**. The display will read
   ACTIVITY=TUNE

6. Use the **NEXT LINE** key to scroll to the TIME function. The display will read TIME=XX,XX.

7. Using military time, type the correct hour, then a comma, then the correct minutes. Then depress **TRANSMIT**.

8. The Mod 30 will print the correct time and date automatically at the bottom of the chart. The procedure is complete, unplug the P Box.

10.5 PLANT SHUTDOWN PROCEDURE (STORM OR EXTENDED POWER OUTAGE)

During scheduled power outages or when it becomes evident that a moderate to severe thunder storm is approaching, perform the following:

1. Secure the EDR units as usually done or select manual stop if a storm is approaching quickly.

2. Record irrigation and potable water totalizer readings in the log book.

3. Inform the Fire Department that the plant will be powered down and that they will receive a "line fault" and Monaco Alarms for Bldg. 462.

4. Close the Irrigation system discharge valve then secure all irrigation pump HOA switches.

5. Secure breakers for: EDR #1, EDR #2, MCC, and Panel A. Be sure to have flashlight at night.

6. During electrical storms it is necessary to open all telephone and telemetry connections to the water plant to avoid possible damage to instrumentation. The Communications Terminal Box (located under the stairway) is utilized to disconnect knife switches for the Telephone, Remote Tank level indicators A and B, and the Fire Department alarm. Disconnect these before lightning gets close to avoid risk of shock.

7. Close all building doors and check outside for things that may be damaged by rain or blow away.

8. Emergency lighting will function in the control room for several hours before emergency candles become necessary.

9. For extended outages, secure CO2 supply to chlorine residual analyzers.

10.5.1 PLANT RE-ENERGIZING PROCEDURE

1. Check for proper voltages at the main meter panel using the selector switch. If normal voltages exist, proceed to step #2. If not, attempt to notify personnel at Pyramid maintenance, MP desk, and the plant manager.

2. Close all knife switches in the Communications Terminal Box. Test telephone function and verify level indication.

3. Call the Fire Department and notify them of power up. Inform them they will get an alarm until you can clear the RIS and Monaco alarm panels.

4. Reset all alarms and totalizers, inspect gauges, lighting, etc. Print out previous totalizer figures and attach below totalizer to be added to end of month figures.

5. Open irrigation pump drains and discharge bleed valves momentarily to expel any air. Energize one pump at a time while checking prime. NEVER run any pump dry as the seals will self destruct! Open irrigation system discharge valve slowly to pressurize system.

6. Chlorine residual analyzers will require adjustment after stabilizing.

7. In case of hydropneumatic tank air depletion, isolate air compressors using the valve provided, so that low pressure will not prevent EDR unit feed valve LV-102 from operating.

8. As with all power outages, perform two-buffer calibration on the lab pH meter.

10.6 CHLORINE LEAK DETECTOR TEST PROCEDURE

1. Notify the Fire Department of intentions to test the chlorine leak detector.

2. While holding a 150 mL plastic beaker below suction inlet pipe, mix 1 dropperful vinegar with 1 dropperful bleach in beaker. The alarm should respond within seconds.

3. Rinse the electrode with distilled water using a wash bottle.

4. Verify that the Fire Department also received the alarm. Reset the Monaco system following the test.

   NOTE: Electrolyte drip rate at the sensor should be one drop every 1 to 10 minutes depending on ambient temperature and barometric conditions.

10.7 READING KILOWATT HOUR METER

1. The kilowatt hour meter for the plant has a row of four dials, each having a pointer that falls on or between a number. Some pointers move clockwise while others move counterclockwise.

2. Read one dial at a time, writing down the number the pointer has just passed. Write the numbers in the order the dials appear.

3. If the pointer falls between two numbers, read the smaller number. If the pointer falls directly on a number - say seven - read it as a seven only if the pointer on the **immediate right** has passed zero. Read it as a six if the pointer to the immediate right is only approaching zero.

   NOTE: Because you may need to know the position of the pointer to the right, some people read the dials right to left. Regardless, the numbers should be written left to right.

10.8 AUTO-DIALER INFORMATION AND INSTRUCTIONS

CONTENTS:

E.1 Programming phone numbers
F.1 Testing the auto-dialer
G.1 Troubleshooting

GENERAL DESCRIPTION

The auto-dialer is designed to call three numbers in the event of an alarm code and play a prerecorded message. The dialer is dependent upon the fire alarm panel for the alarm signals and will not activate individually. It functions via a YPG phone line and therefore will require a 9 to be dialed first before any outside numbers can be called. The dialer may also be switched to play the message through the dialer internal speaker. This feature is controlled by the monitor switch and is either on or off.

A.1 LOCATION:

The auto-dialer is located in the northeast corner of the process area beneath the fire alarm panel in a gray junction box. To access the dialer, loosen the four screws and remove panel. The dialer may then be repositioned in the junction box for access to the dialer's keypad.

B.1 SELECTING THE NUMBER OF DIAL ATTEMPTS:

The dialer may be set to make either **ONE** attempt or **THREE** attempts at contacting the stored numbers. To switch between settings perform the following steps:

1. Press the [TEST] button on the dialer keypad.
2. Press the [0] button.

If the dialer sounds a tone then you have set it to make three attempts. If the dialer does not sound a tone then it is programmed to make only one attempt.

C.1 RECORDING AN OUTGOING MESSAGE:

The dialer will store one message of up to twenty seconds in memory. To record a message perform the following steps:

1. Press the [RECORD] key on the dialer face and wait for the red indicator light to come on.
2. Speak clearly into the microphone on the front of the dialer.
3. If your message is less than twenty seconds then press [RECORD] when you are done recording your message.

D.1 ERASING NUMBERS FROM MEMORY:

Before a number can be stored it is necessary to erase the memory location first. To erase one of the stored numbers perform the following:

1. Press [STORE].
2. Press [1], [2], or [3].
3. Press [STORE].

The dialer should sound a series of beeps for about one second.

E.1 STORING TELEPHONE NUMBERS IN MEMORY:

Up to three separate numbers can be stored in the dialer's memory. Each phone number cannot exceed 16 digits. To store a number to memory perform the following:

1. Press [STORE].
2. Press [1], [2], or [3] to indicate the memory location to be programmed.
3. Press [9] then [PLAY].
4. Enter the phone number using the keypad.
5. Press [STORE].

When you complete step 5 the dialer should sound a series of four beeps lasting approx. one second. If you do not hear these beeps then the number was not stored and steps 1-5 must be repeated. See trouble section.

F.1 TESTING THE DIALER:

Using the dialer's incorporated test feature each memory location can be tested individually. Please remember to first inform the involved parties. Perform the following:

1. Press [TEST].
2. Press [1], [2], or [3] to selected the number to be tested.

The dialer will now attempt to call the number chosen. The party called should receive your recorded outgoing message. If there is no answer the dialer will end its test mode. Repeat steps 1 and 2 to test all the programmed numbers.

G.1 TROUBLESHOOTING:

CANNOT STORE PHONE NUMBERS;

Be sure the locations you are trying to program have first been erased. Next repeat the instructions again. If you don't hear the four beeps press the [STORE] again. Now repeat the instructions again. The [STORE] button is similar to an on/off switch and it is possible to get ahead of yourself so that you are turning off a function instead of turning it on. Thus if you do not hear the four beeps at the end of a programming attempt by pressing [STORE] again you should be able to get on the right track again.

CANNOT ERASE PHONE NUMBERS;

As with the above description be sure you are in synch. with the store button.

APPENDIX A

INFORMATIONAL REFERENCES

The following list of references are located in the Control Room of the YPG Water Treatment Plant. These additional sources of information are supplemental to that which is provided in this manual and are considered essential in understanding the theory and rules governing the proper operation and maintenance of this plant.

1. "WATER TREATMENT PLANT OPERATION", VOLUME 1, THIRD EDITION, CALIFORNIA STATE UNIVERSITY, SACRAMENTO SCHOOL OF ENGINEERING.

2. "WATER TREATMENT PLANT OPERATION", VOLUME 2, SECOND EDITION, CALIFORNIA STATE UNIVERSITY, SACRAMENTO SCHOOL OF ENGINEERING.

3. "SMALL WATER SYSTEM OPERATION AND MAINTENANCE", THIRD EDITION, CALIFORNIA STATE UNIVERSITY, SACRAMENTO SCHOOL OF ENGINEERING.

4. "WATER DISTRIBUTION SYSTEM OPERATION AND MAINTENANCE", SECOND EDITION, CALIFORNIA STATE UNIVERSITY, SACRAMENTO SCHOOL OF ENGINEERING.

5. "IONICS OPERATION AND MAINTENANCE MANUALS", YUMA PROVING GROUND VOLUMES I & II, AQUAMITE XX, AUGUST, 1988.

6. "OPERATION AND MAINTENANCE ANNUAL REPORTS OF THE EDR WATER TREATMENT FACILITY AT YUMA PROVING GROUND, YUMA, ARIZONA" for the years 1987 through 1999, prepared by: Dave Slater, Plant Manager, D & S Services.

7. "SAFE USE OF CHEMICALS IN THE WORKPLACE - RIGHT TO KNOW" a mini lesson plan, US Army YPG, OSH Compliance.

8. "SAFETY PRACTICES FOR WATER UTILITIES", American Water Works Association.

9. "MATERIAL SAFETY DATA SHEETS", (updated as required).

10. "STANDARD METHODS FOR THE EXAMINATION OF WATER AND WASTEWATER" 18th Edition, 1992, prepared jointly by: American Public Health Association, American Water Works Association, Water Environment Federation.

APPENDIX B

YPG MAIN POST WATER TREATMENT PLANT OPERATIONS PERMIT

Water

APPROVAL TO OPERATE

Project Description: Electrodialysis reversal system, water storage tank (50,000 gal), Hydro

Location: Yuma Proving Ground Yuma County

Project Owner: U.S. ARMY STEYP-FFP, Yuma, AZ 85364

Approval to operate the above-described facilities as represented in the approved plan documents on file with the Arizona Department of Health Services is hereby given subject to the following provisions:

NONE

SOUTHERN REGIONAL OFFICE FINAL INSPECTION: by Stephen Devereaux on September 9, 1986.

The State law, A.R.S. 36-136., G., 6 or 9, requires that the operation of the project must be in accordance with the rules and regulations of the Arizona Department of Health Services.

Date Approved: 9-11-86

James A. Maston, P.E., Manager
Southern Regional Office
Environmental Health Services

ystem Number 14-403

File No. 810524

APPENDIX C

EQUIPMENT SERVICE AND PARTS SUPPLIER LIST

VENDOR	ADDRESS	PHONE
AIR LIQUIDE	2192 E. HWY 95, YUMA, AZ 85365	602-782-6591
CHLORINATORS & CONTROLS	PO BOX 2747, ESCONDIDO,CA 92025	619-746-5922
ENDRESS & HAUSER	2350 ENDRESS PL., GREENWOOD,IN 46143	317-535-7138
HACH COMPANY	PO BOX 389, LOVELAND, CO 80539	800-227-4224
IONICS INC.	65 GROVE ST.,WATERTOWN, MA 02172	617-926-2500
IONICS INC.	20801 N. 19TH AVE,SUITE 1,PHOENIX,AZ 85027	602-582-2957
LAB SAFETY SUPPLY	PO BOX 1368, JANESVILLE, WI 53547	800-356-0783
NALCO CHEMICAL CO.	6233 W.65TH ST.,CHICAGO, IL 60638	800-288-0879
ORION RESEARCH INC.	529 MAIN ST., BOSTON, MA 02129	800-225-1480
ROSEMOUNT ANALYTICAL	2400 BARRANCA PKWY,IRVINE,CA92714	714-863-1181
VAN WATERS & ROGERS	50 S. 45TH AVE, PHOENIX, AZ 85043	602-272-3272
WALCHEM CORPORATION	5 BOYNTON ROAD, HOPPING BROOK PARK, HOLLISTON, MA 01746	508-429-1110
WISNER CONTROLS	19152 MIDLAND, MOKENA, IL 60448	708-479-0095

APPENDIX D

GOVERNMENT FURNISHED EQUIPMENT LIST

ITEM	DESCRIPTION (NON-EXPENDABLE)	UN	QTY	COST_UNIT	TAG
1	MAGIC CHEF REFRIG MOD#RC-5,SER#74758 (C)	EA	1	$ 195.00	1
2	METER,TDS,MYRON L,MOD#DP4,SER#0671238D (C)	EA	1	$ 349.00	2
3	METER,COND,MYRON L,MOD#DC4,SER#0471482D (C)	EA	1	$ 349.00	3
4	PROGRAMMER,TAYLOR MOD#30 SER# A-2441 (C)	EA	1	$ 500.00	4
5	AMPROBE, MOD#RS1000 (C)	EA	1	$ 95.00	6
6	GAS MASK, WILSON (BATHRM CLOSET)	EA	1	$ 155.00	7
7	IONANALYZER, pH, ORION MOD#920,SER#QY43A (C)	EA	1	$ 1,570.00	8
8	S.C.B.A RANGER, SER# 008166 (C)	EA	1	$ 1,750.00	9
9	CYLINDER REPAIR KIT A. CHLOR SPEC #150 (PROC. AREA, CL2 HSE)	EA	2	$ 1,226.00	11
10	HAND TRUCK (BEHIND CONTROL RM)	EA	1	$ 65.00	12
11	HAND TRUCK FOR 55GAL DRUM, WESCO (W)	EA	1	$ 284.00	13
12	DOLLY, 2`x4`,FOR POLY TANKS (W)	EA	2	$ 200.00	14
13	POLYETHYLENE TANK, 2`X4`X3` (W)	EA	1	$ 295.00	15
14	POLYETHYLENE TANK,2`X4`X1.5`, IONICS (EDR's)	EA	2	$ 200.00	16
15	10` STEPLADDER, WERNER (W)	EA	1	$ 176.00	17
16	6` STEPLADDER, WERNER (W)	EA	1	$ 97.00	18
17	WRENCH SET, SK, 1/4"-7/8" (C)	EA	1	$ 55.00	20
18	WRENCH 1 13/16", INDESTRO (S)	EA	1	$ 40.00	21
19	WRENCH 1 3/4" WRIGHT (S)	EA	1	$ 40.00	22
20	WRENCH, ADJUSTABLE, SET OF 3 (S)	ST	1	$ 50.00	23
21	WRENCH, ADJUSTABLE 15" (S)	EA	1	$ 28.00	24
22	WRENCH, TORQUE, BONNEY (S)	EA	1	$ 112.00	25
23	DRILL, VARIABLE SPEED, MAKITA (S)	EA	1	$ 116.00	26
24	SAWSALL, MILWAUKEE, SER.# 6511 (S)	EA	1	$ 175.00	27
25	VISE GRIPS, SET OF 3 (S)	ST	1	$ 45.00	28
26	CHANNELOCKS, SET OF 3 (S)	ST	1	$ 45.00	29
27	AIR SANDER, ANGLE, CHICAGO PNUEMATIC (S)	EA	1	$ 165.00	31
28	AIR SANDER, ORBITAL, CHICAGO PNUEMATIC (S)	EA	1	$ 80.00	32
89	1/4" ANGLE DIE TOOL, PNEUMATIC, HUSKY (S)	EA	1	$ 48.00	120
29	SPRAY GUN, MILWAUKEE, MOD.# MPS-18 (S)	EA	1	$ 49.00	34
30	DRILL INDEX, 29 PIECE, AMERICAN (S)	EA	1	$ 47.00	35
31	GRINDER, BENCH UNITED, MOD.# 850 (S)	EA	1	$ 94.00	36
32	REGULATOR, CALIBRATOR, LINDE (CALIB. STAND)	EA	1	$ 150.00	37
33	BENCH VISE (S)	EA	1	$ 49.00	39
34	STORAGE LOCKER, FOR FLAMMABLES A&A 145 (S)	EA	1	$ 706.00	40
35	PIPE VISE, PORTABLE (S)	EA	1	$ 52.00	41
36	PIPE DIE SET W/HANDLE RIGID (S)	EA	1	$ 279.00	42
37	PIPE TAP SET- 5 PIECE ACE HANSON (S)	EA	1	$ 110.00	43
38	TAP & DIE SET, 40 PIECE, VRMT. AMERICAN (S)	ST	1	$ 85.00	44
39	LEVEL, CARPENTERS, 4`, MAYES (S)	EA	1	$ 44.00	45
40	PUMP,SELF-PRIMING,PORT.#4320-00X07-5566 (W)	EA	1	$ 55.70	46

41	TABLE, 60 X 34 7110-00-143-0822 COMPUTER TABLE (C)	EA	1	$	223.98	48
42	OFFICE DESK W/FILE DRAWERS (C)	EA	1	$	223.98	49
43	CHAIR STR. W/ARMS (PROCESS AREA)	EA	1	$	37.09	50
44	CHAIR W/O ARMS (SHOP)	EA	1	$	33.40	51
45	CHAIR W/ARMS ROT. (C)	EA	1	$	70.95	52
46	CHAIR W/ARMS ROT. (C)	EA	1	$	45.23	53
47	SCAFFOLD,W/HANDRAILS, MOD.SS0606 LOUISVL (W)	EA	1	$	646.40	56
48	ZINC COLORIMETER, HACH (C)	EA	1	$	215.00	57
49	LEADTRAK COLORIMETER, HACH (C)	EA	1	$	195.00	58
50	VACUUM/BLOWER,W OR D, SHOP VAC 3331.5 (PROC AREA)	EA	1	$	88.97	60
51	CALIPER, DIAL CENTRAL TOOLS (DESK DRAWER in CONTROL RM)	EA	1	$	100.00	61
52	TANK, 15GAL,CONICAL BOTTOM (BY CL2 HSE)	EA	1	$	175.00	62
53	BELT, LINEMAN'S BODY KLEIN TOOLS (OFFICE DESK LWR DRWR)	EA	2	$	123.00	63
54	SCREWDRIVER SET, 12 PIECE SK (ELECTRONICS DRAWER - C)	ST	1	$	90.00	64
55	SLEEVE, FALL PREVENTION NORTH (OFFICE DESK)	EA	1	$	243.00	65
56	SLING, NYLON, 8' (S)	EA	2	$	75.00	67
57	SLING, NYLON, 6' (S)	EA	1	$	60.00	68
58	FILE SET, 7 PIECE, (S)	ST	1	$	45.00	69
59	WHEELBARROW (W)	EA	1	$	45.00	70
60	PULL TAPE, ELECTRICIANS (S)	EA	1	$	60.00	71
61	GAUGE, TEST, 0-200 PSI ASHCROFT (CALIB. STAND)	EA	1	$	237.00	72
62	GAUGE, TEST, 0-100 PSI ASHCROFT (CALIB. STAND))	EA	1	$	237.00	73
63	GAUGE, 0-100 PSI MARSHAL TOWN PERMAGAGE (C)	EA	1	$	100.00	74
64	GAUGE, 0-300 PSI WEKSLER INSTRUMENTS (C)	EA	1	$	100.00	75
65	GAUGE, 0-30 PSI WEKSLER INSTRUMENTS (C)	EA	1	$	100.00	76
66	CALIBRATOR, FLOWMETER 0-160" TAYLOR (C)	EA	1	$	202.00	77
67	STIRRER, MAGNETIC THERMOLYNE (C)	EA	1	$	150.00	78
68	WORKBENCH, 4` X 8` (SHOP)	EA	1	$	200.00	79
69	WORKTABLE, 34" X 48" (PROC. AREA and SHOP)	EA	2	$	200.00	80
70	PARTS BIN, 49" X 72" X 13" (S)	EA	3	$	200.00	81
71	MEMBRANE BIN, 47" X 72" X 24" (S)	EA	1	$	200.00	82
72	STACK PROBE MODEL V (C)	EA	1	$	125.00	83
73	NITROGEN CYLINDER, 40 CU. FT. (CALIB. STAND)	EA	1	$	100.00	84
74	DISSOLVED OXYGEN METER SET MOD#082000 (C)	EA	1	$	995.00	85
75	HANDBOOK OF WATER PURIFICATION (C)	EA	1	$	139.00	86
76	WATER ANALYSIS, BOOK (C)	EA	1	$	114.00	87
77	CHAIR, TAN UPHOLSTERED (C)	EA	2	$	96.56	88
78	FILING CABINET, (C)	EA	1	$	160.25	89
79	TABLE, OFFICE, 60X30, OAK, (C)	EA	1	$	100.00	97
80	METER, TDS, MYRON L, DP4,SER#1230848D (C)	EA	1	$	380.00	99
81	STACK PROBE, MODEL H (C)	EA	1	$	140.00	100
88	DRUM TRUCK (W)	EA	1	$	265.00	119
91	DREMEL TOOL (S)	EA	1	$	80.00	122
92	SMALL HAND TRUCK (CALIBRATION STAND)	EA	1	$	20.00	123
90	LUTZ CHEM. TRANSFER PUMP/MOTOR SN#30002014910 (E.MN DR)	EA	1	$	648.00	121
82	LUTZ CHEM. TRANSFER PUMP/MOTOR SN#30002008012 (E. MN DR)	EA	1	$	542.00	111

83	MULTIMETER, FLUKE 23-3 SN#70791155 (C)	EA	1	$	199.00	112
84	MYRON L CONDUCTIVITY METER, MODEL AR1, Ser #00742 (C)	EA	1	$	359.00	113
85	3/8" DRIVE RATCHET PNUEMATIC, CRAFTSMAN (S)	EA	1	$	75.00	114
86	PVC WELDER, LARAMIE (S)	EA	1	$	1,100.00	115
87	MONITOR, DX17F, S/N 1934158881 (C)	EA	1	$	659.00	117
93	PRESSURE REGULATOR 0-100 PSI (CALIB. STAND)	EA	1	$	151.00	124
94	PRESSURE REGULATOR 0-200 PSI (CALIB. STAND)	EA	1	$	151.00	125
95	PROG. ELECTRONICS TONE AND PROBE KIT, CC701K	EA	1	$	103.00	126
96	1/4" ANG. GRINDER ST. LOUIS PNEUM.MOD SLP-83150, SER02929251	EA	1	$	135.00	127
97	4" MAKITA GRINDER, MOD#9523NBH, SER# 0469649	EA	1	$	58.00	128
98	HEWLETT PACKARD LASERJET 1012, SER# CNFB103006	EA	1	$	189.00	131
99	HP 420 VECTRA, BT366 CPU-N, US14804099, P4-1600 256-38-7	EA	1	$	999.00	132
100	DELL MONITOR, CJ511, BADY, CRT 17"	EA	1	$	140.00	1330

APPENDIX D
GOVERNMENT FURNISHED EQUIPMENT LIST
NONEXPENDABLE

ITEM	DESCRIPTION (DURABLE)	UN	QTY	COST
1	CABINET, PARTS ORGANIZER (CONTROL RM & SHOP)	EA	10	18
2	HYDRAULIC TROLLEY JACK M#58887 (SHOP - BENCH)	EA	1	30
3	TAPE, MEASURING, 30', STANLEY (SHOP - S)	EA	1	19
4	GAUGE, 0-15", VACUUM (CONTROL RM - C)	EA	1	39
5	GAUGE, 0-60" (C)	EA	1	31
6	WRENCH, 55 GAL. DRUM (PROCESS AREA BY LUTZ PUMPS)	EA	1	16
7	DRESSING TOOL, GRINDER (S)	EA	1	7.5
8	PLIERS, CHANNELLOCK (S)	EA	1	11
9	TAPE, MEASURING, 10', LUFKIN (S)	EA	1	7
10	FEELER GAUGE, #223, CAL VAN (S)	EA	1	3.35
11	WRENCH SET, ALLEN, SMALL (S)	EA	1	4
12	WAND, MAGNETIC (S)	EA	3	3
13	PLIERS, INTERNAL RETAIN. RING (S)	EA	1	15
14	PLIERS, EXTERNAL RETAIN. RING (S)	EA	1	15
15	TUBING BENDER (W)	EA	1	15
16	WRENCH, CRESCENT ADJUST. 12" (S)	EA	1	15
17	WRENCH, PIPE, 14" (S)	EA	2	15
18	WRENCH, PIPE, 10" (S)	EA	1	12
19	FILE, 8" (TOOL BOX - SHOP)	EA	1	6
20	WRENCH SET, COMB., KAL TOOL (TOOL BOX - SHOP)	EA	1	22
21	SCREWDRIVER SET, JEWELERS (C)	EA	2	6
22	DIE, 3/4" NF (S)	EA	1	12
23	TAP, 3/4" NF (S)	EA	1	12
24	PLIERS, SIDE CUTTING, SMALL (S)	EA	1	6
25	PLIERS, SIDE CUTTING, MEDIUM (S)	EA	1	7
26	PLIERS, SIDE CUTTING, LARGE (S)	EA	1	12
27	TUBING CUTTER, UP TO 1-5/8" (S)	EA	1	25
28	TUBING CUTTER, UP TO 1/2" (S)	EA	1	15
29	HACKSAW (S)	EA	1	10
30	TIN SHEARS, LARGE (S)	EA	1	25
31	TIN SHEARS, SMALL (S)	EA	1	12
32	KNIFE, TAPING, 12" (S)	EA	1	10
33	KNIFE, TAPING, 3" (S)	EA	1	4
34	KNIFE, TAPING, 1-1/2" (S)	EA	1	3
35	CHISEL SET, WOOD, 3-PIECE (S)	EA	1	25
36	SAW, CARPENTERS, RIP (S)	EA	1	15
37	CONDUIT BENDER, 1/2" (S)	EA	1	20
38	WORKLIGHT, FLUORESCENT, 2' (S)	EA	1	30
39	WORKLIGHT, INCANDESCENT (S)	EA	1	15
40	HOSE, PNEUMATIC, 3/8" (S)	EA	3	15
41	SPRAYER, CHEMICAL (S)	EA	1	25
42	PRYBAR, 24" (S)	EA	2	20

43	GREASE GUN (S)	EA	1	25
44	SHOVEL, SQUARE END (CL2 HS)	EA	3	15
45	SHOVEL, ROUND POINT (CL2 HS)	EA	2	15
46	RAKE, YARD (CL2 HS)	EA	1	15
49	C-CLAMP, 6" (S)	EA	1	15
50	C-CLAMP, 4.5" (S)	EA	1	12
51	SQUARE, COMBINATION, 12" (S)	EA	1	15
52	LEVEL, TORPEDO (S)	EA	1	12
53	AIR NOZZLE (S)	EA	1	10
54	RULE, 48" (S)	EA	1	10
55	PLIERS, NEEDLE NOSE, MEDIUM (S)	EA	1	10
56	PLIERS, NEEDLE NOSE, SMALL (S)	EA	1	7
57	PLIERS, SLIP JOINT (S)	EA	1	6
58	BREAKER BAR, 3/4" DRIVE (S)	EA	1	25
59	BREAKER BAR, 1/2" DRIVE (S)	EA	1	15
60	WRENCH, COMB, 1-1/8"CHALLENGER (S)	EA	1	20
61	WRENCH, COMB, 15/16" CRAFTSMAN (S)	EA	1	12
62	SCREWCRIVER SET, GOV'T, 10 PC (C)	EA	1	15
63	NUT DRIVER SET, 6 PC (S)	EA	1	25
64	SOCKET SET, 3/8" DR, 7/16-3/4" (S)	EA	1	20
65	WRENCH SET, ALLEN, 3/16"-3/8" (S)	EA	1	25
66	WRENCH SET, ALLEN, 5/16"-3/8" (S)	EA	1	10
67	HAMMER, BALL PEE, SMALL (S)	EA	1	10
68	HAMMER, BALL PEEN, MEDIUM (S)	EA	1	18
69	HAMMER, CARPENTERS (S)	EA	1	15
70	HAMMER, DEAD BLOW, HAND SLEDGE (S)	EA	1	15
71	ROPE, LANYARD (S)	EA	1	35
72	STOP WATCH, ELECTRONIC (C)	EA	3	15
73	DRIVE PIN PUNCH SET (S)	EA	1	26
74	DESOLDERING TOOL (C)	EA	1	5
75	SOLDERING IRON (C)	EA	1	15
76	MULTIMETER, GC (C)	EA	1	15
77	SOCKET SET,3/8"IMPACT,3/16-3/4 (S)	EA	1	35
78	SANDBLASTER, 1 QUART (S)	EA	1	36
79	SCREW PIN SHACKLE (S)	EA	1	80
80	WRENCH, 5' TEE HANDLE (W)	EA	1	50
81	LAMP, ULTRAVIOLET (C)	EA	1	22
82	KNEE PADS, PAIR (C)	EA	1	11
83	EVAP. COOLER PUMP (S - BENCH)	EA	1	7
84	TURNBUCKLE HOOK AND EYE (S)	EA	1	33
85	FUSE PULLER, SMALL (C)	EA	1	6
86	FUSE PULLER, LARGE (C)	EA	1	9
87	WATER TRTMNT PLANT OP MANUAL VOL 1 (C)	EA	1	30
88	WATER TRTMNT PLANT OP MANUAL VOL 2 (C)	EA	1	30
89	WATER DISTR SYSTEM O&M (C)	EA	1	20
90	SMALL WATER SYSTEM O&M (C)	EA	1	20

91	CHAMPION WORK BELT, MEDIUM (LOCKERS)	EA	2	36.25
92	CHAMPION WORK BELT, LARGE (LOCKERS)	EA	2	36.25
93	VALVE WRENCH (S)	EA	1	37
47	STRAP WRENCH 14" (S)	EA	1	25
94	MAKITA 1/4 SHEET ELEC. SANDER MODEL# BO4552 (S)	EA	1	47
97	FLEXIBLE RAKE	EA	1	7
48	STRAP WRENCH 24" (S)	EA	1	69
95	RAZOR SAW	EA	1	20
96	CALCULATOR, TEXAS INSTRUMENTS	EA	1	9
98	GREASE GUN	EA	1	8
99	4 PIECE SET OF PULLERS	EA	1	22

APPENDIX E

EXPENDABLE SUPPLIES INVENTORY

ITEM	LOCATION	DESCRIPTION (NONEXPENDABLE)	COST	MQR	QOH
1	A1	WTV O-RING P26482 A1	0.5	8	5
2	A1	WTV PLUG GASKET SEAL P34530 A1	1.2	8	7
3	A1	WTV ORIFICE P37657 A1	5	8	7
4	A1	WTV CLAMPING SCREW P37663 A1	2	1	1
5	B4	WTV VALVE STEM U 25891 B4	40	2	6
6	B4	WTV SEAT P 50552 B4	12	2	4
7	B4	WTV STEM UNIT U 17638 B4	47	2	1
8	B5	WTV STEM VALVE PRESS/CK U 26875 B5	91	2	3
9	B5	WTV SEAT P 50532 B5	28	1	1
10	C	WTV PM KIT FOR CHLORTR U26218 C	150	2	2
11	C	WTV V-500 MAST CTRL 0-10#/2 C	925	1	1
12	C	WTV VAC REG. CHK UNIT U25892 C	925	1	1
13	C	WTA AMM SOL 4OZ. U409 C	12	2	0
14	C	WTA VALVE BODY U26662 C	55	2	2
15	C	WTA FLEX CONN, 4' UXB493 C	34	2	2
16	C1	WTA VV YOKE CYL U28110 C	100	1	2
17	C2	WTA PM KIT VAC REG U25952 C	78	2	2
18	D1	WTA TERM SEAL P52607 D1	1.5	2	2
19	D1	WTC ELECT TERM P52582 D1	28	2	8
20	D1	WTC O-RING, P25900 D1	0.25	2	7
21	D1	WTC ELECT UNIT U25316 D1	22	2	8
22	D5	WTC ELECT UNIT U25563 D5	270	2	2
23	D5	WTC TERM COVER U27670 D5	1	2	2
24	D11	WTC CO2 REGULATOR U26447 D-11	110	1	1
25	C	WTE AMP. CIRC. BRD U24760 C	350	1	1
26	C	WTE FEEDBK CIRC BRD U24815 C	200	1	2
27	C	WTE PWR SUPPLY CIRC BRD U22401 C	150	1	1
28	C	WTE MOTOR (5.97RPM) U22369 C	160	1	1
29	C	WTE TRANSFRMR T-15 U21874 C	60	1	1
30	C	WTE TRANSFRMR T-25 U22362 C	40	1	1
31	E1	WTL GROMMET P52549 E1	2	1	1
32	E2	WTL WASHER P54654 E2	1	1	2
33	E2	WTL FUSE P53073 E2	2	2	6
34	E2	WTL GLASS ORIFICE P54326 E2	5	1	1
35	E2	WTL FILTER P54515 E2	2	2	3
36	E5	WTL CHARCOAL FILTER U26190 E5	8	2	3
37	C	WTL ELECTROLYTE CONC. U25660 C	50	1	1.5
38	N2	WTL FAN MOTOR 3M HP G5252 N2	30	1	2
39	E3	WTL CLEANING WIRE P26488 E3	8	1	1

40	F1	WAL COUPLING NUT 10299 F1	2	2	4
41	F1	WAL CLAMP RING 26136 F1	0.5	2	2
42	F2	WAL VALVE HOUSING 10493-1 F2	8	2	3
43	F3	WAL SEAL 10973 F3	2	2	7
44	F5	WAL SPARE PARTS KIT SP-U7 F5	35	2	10
45	G1	WAL KNOB 25891 G1	7	2	1
46	G2	WAL PULSER 115V 25559-1 G2	43	2	2
47	G3	WAL VARISTOR 130V 10626 G3	5	2	2
48	G3	WAL KNOB 25899 G3	7	2	3
49	G4	WAL SCREW 10-24 x 3/4" 10340 G4	0.5	4	4
50	G5	WAL CHEMICAL INJ. CK V.V. 25029 G5	20	2	5
51	H1	WAL SPARE PARTS KIT SP-U5 H1	60	2	5
52	J5	EH PREAMPLIFIER EC111-001A J5	175	2	3
53	K1	ROS O-RING 9550010 K1	5	2	1
54	K2	ROS JUNC ASSEM WOOD 2000734 K2	20	2	0
55	K5	ROS WASHER 3001839 K5	2	2	2
56	C	ROS GEL SOLUTION 9210102 C	25	1	1.2
57	K1	ROS O-RING 9550044 K1	9	2	1
58	K2	ROS PREAMPLIFIER 22698-03 K2	275	1	2
59	K3	ROS DBL JUNC REF ELECT 2299400 K3	135	2	0
60	K4	ROS ATC PROBE 23123-01A K4	100	1	2
61	K5	ROS GEN PURP PH PROBE 2001553 K5	105	2	1
62	C	NAL SOL # SO226 (ALK) GAL. C	31	2	0.9
63	C	NAL SOL # SO274 (TH,CA) GAL. C	35	2	2.4
64	C	NAL SOL# SO407 (7.0BUF) GAL C.	37	2	1.2
65	C	NAL SOL SO406 (4.0BUF) GAL. C	36	2	1.8
66	C	NAL SOL # SO275 (H-2) 500ml C	20	2	0.2
67	C	NAL SOL# SO279 (H-6) 500ml C	18	2	1
68	C	NAL SOL # SO277 (TH IND) 250gr C	21	1	0.4
69	C	NAL SOL # SO280 (CA IND) 250gr C	22	1	0.3
70	C	NAL SOL # SO102 (M IND) 500ml C	23	1	1.8
71	C	NAL BURRETTE ASS # PO412 C	60	1	1
72	C	NAL BLUE BULB # P2403 C	0.5	5	7
73	C	NAL RUBR SQZE BULB # P2401 C	5	2	1
74	C	HCH DPD FR CL2 PIL M/PK 14077-28 C	105	1	0.5
75	C	HCH COLOR VIEW TUBE, 5ML 1730-00 C	2	5	14
76	C	HCH PHOSVR 3 PILS, 100 EA 2209-99 C	14	1	0.5
77	C	ORI REF FILL SOL 2OZ 900001 C	10	2	0.8
78	C	ORI REF FILL SOL 2OZ 900011 C	10	3	3
79	C	ORI 1 PPM, FL STD SOL 040906 C	37	3	7.5
80	C	ORI 2 PPM FL STD SOL 040907 C	37	3	8.6
81	C	ORI 10 PPM FL STD SOL 040908 C	37	2	8
82	C	ORI TISAB GALS. 940909 C	63	2	3
83	C	ORI PROBE 9102 BN C	115	2	1
84	C	ORI EPOXY ATC PROBE 917001 C	140	1	1
85	C	ORI MEMBRANE CAP (DO) 080010 C	28	1	2

86	C	TAY THERMAL CHART PAPER 82S1 C	3.75	10	136
87	A-7	GLD FUSE A60X50 DPC2290251 A-7	20	18	50
88	A-7	GLD FUSE A60X80 DPC 2290 A-7	25	9	30
89	A-7	GLD FUSE A60X200 DPC2290324 A-7	30	9	23
90	A-9	HYWD 3-WAY VV KIT DPC3310311 A-9	30	6	6
91	A-9	HYWD 3-WAY VV RPR KIT 33106 A-9	150	3	4
92	E-10	ION HYWD 4" VV RPR KIT TB10400 E-10	162	2	2
93	E-10	ION HYWD 4" VV KIT 33110940 E-10	52	2	2
94	A-10	ION ASAHI, DIAPHM, 4"VV TYPE G A-10	60	2	2
95	A-10	ASAHI, DIAPHM, 4" VV TYPE 72 A-10	60	2	2
96	A-10	ASAHI, DIAPHM, 3" VV TYPE G A-10	52	2	2
97	A-10	ASAHI, DIAPHM,3" VV TYPE 72 A-10	52	2	2
98	A-10	ASAHI, DIAPHM, 2" VV TYPE G A-10	25	2	2
99	A-10	ASAHI, DIAPHM, 2" VV TYPE 72 A-10	25	2	2
100	A-10	JAMESBURY 12" DIAPHM RKQ3 A-10	90	1	1
101	A-10	ROLL SEAL, VALVE LINER A-10	30	1	1
102	B-1	AB H/O/A SWITCH, 800TJ17A B-1	15	1	1
103	B-1	AB SWCH CONT,800T-XA SER C B-1	4	2	3
104	B-2	AB RLY, 24VAC/3A, 700HC14A24 B-2	10	2	2
105	B-2	AB RLY, 24VDC/10A 700HA32Z24 B-2	10	2	2
106	B-3	AB RLY,120V/10A, 700HB32A1 B-3	10	2	3
107	B-3	AB 8 PIN SOCKET HN100 B-3	5	2	3
108	B-3	POT BRUM RLY 120V/KAP11AG-120 B-3	10	2	5
109	B-3	POT BRUM RLY 24VAC/KRP11AG B-3	10	2	4
110	B-4	AROMAT RLY 115V/DPC 2131773 B-4	10	2	22
111	B-4	AMF RLY 28VDC/0.3A, DPC2130530 B-4	10	2	2
112	B-4	OMRON RLY 120V DPC2130706 B-4	10	2	6
113	B-8	SEL. VV,6-WY DPC3201619 B-8	300	1	1
114	B-9	1" VV KIT HYWD DPC3310698 B-9	14	4	10
115	F-5	HOSE CLAMPS, 2.75" D-8	2	6	10
116	B-12	WESTINGHOUSE HTRS FH-18 B-12	5	6	6
117	B-12	WESTINGHOUSE HTRS FH-19 B-12	5	6	6
118	B-12	WESTINGHOUSE HTRS FH-49 B-12	5	6	12
119	B-12	WESTINGHOUSE HTRS FH-79 B-12	5	6	9
120	M4	ELECTRD GROM.TRAP.DPC8016000 M4	8	4	6
121	M4	ELECTRD GROM.RECT.DPC5900379 M4	8	4	14
122	M5	1/4-20 X 3/4" SS BOLT 100 COUNT	10	1	1
123	M5	1/4" SS LOCK WASHER, 100 COUNT	5	1	1
124	S	LOWER TRAY DPC0801119 S	211	1	2
125	B-8	1/2 PRESS REG VV DPC3320527 B-8	120	1	2
126	B-11	PILOT CONTROL VV P4029004 B-11	90	1	3
127	WH	FILTER CART .DPC3840131 WH.	4	90	420
128	H-1	SPCR INTRMEMBR DPC5300321 H-1	25	30	11
129	H-1	SPCR MANIFOLD DPC5300584 H-1	61	8	11
130	H-2	HVY CAT. MEMBR DPC5200750 H-2	107	0	12
131	H-3	ANION MEMBR. DPC5200253 H-3	62	0	90

132	H-4	CATION MEMBR. DPC5201679 H-4	62	0	50
133	H-5	TOP ELECTRODE DPC5500609 H-5	1600	2	2
134	H-6	BOTM ELECTRODE DPC5500608 H-6	1600	2	1
135	A-1	ACTUATOR MOV DPC3310531 A-1	800	2	2
136	A-2	MERCURY RLY 3PST DPC2130106 A-2	300	3	4
137	A-3	MERCURY RLY DPST DPC2130084 A-3	200	3	3
138	A-4	CONDUCTIVITY OUTPUT BRD A-4	200	1	0
139	A-4	CONDUCTIVITY CELL DPC1050834 A-4	551	2	1
140	A-5	WORTH IMPLR DPC3010724 A-5	250	1	1
141	A-5	WORTH GASKET SLEEVE OUTER A-5	2	4	14
142	A-5	STAINLESS STEEL COLLAR A-5	20	1	1
143	A-5	WORTH O-RING (SHAFT SLEEVE) A-5	2	4	10
144	A-5	WORTH GASKET CASING DPC3010805 A-5	12	4	8
145	A-5	WORTH BR RG ADPT DPC96018800 A-5	200	2	2
146	A-5	WORTH DL RG ADPT DPC96019000 A-5	200	1	1
147	A-5	WORTH RNG CAS DPC39001200 A-5	200	2	2
148	A-6	WORTH MECH SEAL DPC3000222 A-6	450	4	1
149	A-6	WORTH SHFT SLEEV DPC3000265000 A-6	450	4	2
150	A-8	US GG 0-100 PSI 13265H37BLBM A-8	100	2	4
151	A-8	HELCD GG.0-160 PSI DPC1011278 A-8	308	1	1
152	A-12	MERIAM FLWMTR DIL DPC090160 A-12	1830	1	1
153	A-12	MERIAM FLWMTR BR. DPC1090135 A-12	1830	1	1
154	A-12	MERIAM DIFF MTR DPC1090101 A-12	1300	1	0
155	B-6	PLAT GRND ROD 3" DPC700134 B-6	31	2	2
156	B-6	PLAT GRND ROD 6" DPC700126 B-6	32	2	6
157	B-5	AB TDR 0-10 SEC 7AR-700HTM B-5	71	2	1
158	B-5	PREC.TDR 3-S 632-15F/2R113S B-5	46	2	8
159	B-5	AB VARIABLE TDR HRM12TA17	62	5	10
160	B-5	AB 1-10 SECOND TDR 700-HTM 12MA1 B-5	50	2	1
161	D-6	UE PRESS SWITCH 100PSI MDL 555 D-6	150	1	0
162	B-7	GF SOLENOID OPERATED VV 3BAR B-7	290	2	2
163	B-10	WESTON LED DISPLY DPC1021206 B-10	200	1	1
164	B-10	TIMER CYCLE TYPE DPC2380790 B-10	110	1	1
165	N2	INTERMATIC TIMER MOTOR WG-730-2 N2	14	1	1
166	E-6	ASCO SOL VALVE KIT 302899 E-6	30	1	2
167	E-6	ASCO SOL VALVE KIT FV302297 E-6	30	2	2
168	E-6	ASCO SOL VALVE KIT 302332 E-6	52	3	4
169	C	GREENLEE PHASE PROTECT 5811-480 N2	80	1	1
170	S	CLAMP. BAR 18.75" DPC0802760 S	25	4	9
171	WH	DIL FEED PUMP MTR 55DG 30HP WH	3312	1	1
172	WH	BRINE PUMP MTR 55DEG 15HP WH	1700	1	1
173	WH	POT/IRRIG PUMP MTR 25HP WH	650	1	1
174	G-10	FLOWMATIC CHK VV 6" MOD888 C-12	240	2	2
175	C-9	PACO SLEEVE C-9	50	2	9
176	C-9	PACO WEAR RING #04001307B C-9	25	1	6
177	C-10	PACO WOODS SURE-FLEX #8 8SC35 C-10	52	1	2

178	C-10	PACO WOODS INSERT #23030008-E C-10	66	1	4
179	L1	ES FUSE, FNQ 6/10 L1	4	10	10
180	L1	ES FUSE, FNM 8/10 L1	4	10	18
181	L2	ES FUSE, FNM 2.5 L2	4	10	8
182	L2	ES FUSE, KTK 3 L2	4	10	16
183	L3	ES FUSE, KTK 8 L3	4	10	8
184	M1	ES FUSE, 3.15 AMP MINIATURE M1	1	5	3
185	M1	ES FUSE, .25 AMP 3AG M1	1	10	16
186	M1	ES FUSE, MDL-1 AMP M1	1	5	5
187	M2	ES FUSE, 5 AMP, AGX 5 M2	1	5	9
188	E-7	ES FUSE, FTRN 250AMP FRS-R 250 E-7	73	3	3
189	E-7	ES FUSE, FTRN 200AMP FRS-R 200 E-7	37	3	3
190	N1	ES WEST MTR STRTR CONTSZ 3 N1	110	1	1
191	N1	ES WEST MTR STRTR CONT SZ 2 N1	95	1	1
192	N1	ES WEST MTR STRTR CONT SZ 1 N1	86	1	1
193	C	ES EIL INSTR IND. 4-20MA 884765 C	185	1	1
194	C	4-20 MA/PULSE CONVERT 7500-5016 C	300	1	2
195	C-14	PVC 1/2" 90 ELL SxS SCH80 C-14	1	2	2
196	C-15	PVC 1/2" 90 ELL SxTHD SCH80 C-15	1	2	6
197	C-15	PVC 1/2" 90 ELL THD SCH80 C-15	1	2	12
198	C-16	PVC 3/4" 90 ELL S SCH80 C-15	2	2	5
199	C-16	PVC 1" 90 ELL S SCH80 C-16	2	2	10
200	D-14	PVC 1/2" 45 ELL S SCH80 D-14	2	2	2
201	D-14	PVC 3/4" 45 ELL S SCH80 D-14	3	2	3
202	E-13	PVC 1/2" TEE THD SCH80 E-13	3	2	2
203	E-13	PVC 1/2" TEE S SCH80 E-13	3	2	3
204	E-14	PVC 3/4" TEE S SCH80 E-14	3	2	4
205	E-15	PVC 1" TEE S SCH80 E-15	4	2	5
206	E-16	PVC 1/2" CPLNG THD SCH80 E-16	2	2	5
207	E-16	PVC 1/2" ML ADP MIPxS SCH80 E-16	2	2	9
208	E-16	PVC 1/2" FEM ADP FIPxS SCH80 E-16	2	2	0
209	E-17	PVC 3/4" ML ADP MIPxS SCH80 E-17	3	2	3
210	E-17	PVC 3/4" FEM ADP FIPxS SCH80 E-17	3	2	4
211	E-17	PVC 3/4" CPLNG THD SCH80 E-17	4	1	4
212	E-18	PVC 1" ML ADP MIPxS SCH80 E-18	4	2	2
213	E-18	PVC 1" FEM ADP FIPxS SCH80 E-18	4	2	12
214	D-16	PVC 1"x 1/2" RDCR S SCH80 D-16	2	2	5
215	D-16	PVC 3/4"X 1/2" RDCR S SCH80 D-16	2	2	4
216	D-16	PVC 1"x 3/4" RDCR S SCH80 D-16	2	2	0
217	F-15	PVC 1/2" COUPLING S SCH80 F-15	2	2	11
218	F-15	PVC 3/4" COUPLING S SCH80 F-15	2	2	4
219	F-16	PVC 1" COUPLING S SCH80 F-16	3	2	12
220	F-16	PVC 2" COUPLING S SCH80 F-16	5	2	4
221	F-17	PVC 2"x12" NIPL TBE SCH80 F-17	5	4	4
222	F-18	PVC 2.5" COUPLING S SCH80 F-18	3	4	7
223	A-13	PVC 4" COUPLING SLIP SCH80 A-13	10	1	1

224	A-14	PVC 4" FLANGE SLIP SCH80 A-14	15	2	2
225	A-15	PVC 4" 90 ELL SLIP SCH80 A-15	10	2	5
226	A-16	PVC 4" 45 ELL SLIP SCH80 A-16	10	2	1
227	A-17	PVC 4" TEE SLIP SCH80 A-17	15	2	4
228	C	PVC 1/4" LAB COCK SHUT-OFF VV C	9	2	7
229	C	PVC 1/4" SAMPLE COCK - BARB HOSE C	13	2	5
230	B-15	PVC 1/4" NDL VLV ANG 5251-002 B-15	21	2	4
231	C-17	PVC 1/2" BALL VLV HAYWARD C-17	11	2	6
232	C-18	PVC 1/2" 3-WY BALL VV HYWD C-18	30	2	7
233	D-17	PVC 1" CHK VLV HAYWARD D-17	38	2	2
234	D-18	PVC 1" BALL VALVE HAYWARD D-18	18	2	8
235	F-14	PVC 2.5"x2" RDR BUSH. S SCH80 F-14	5	3	3
236	F-14	PVC 4"x3" RDR BUSH. S SCH80 F-14	10	1	1
237	G-13	PVC 3" FLANGE SLIP SCH80 G-13	12	1	0
238	G-13	PVC 2.5" FLANGE SLIP SCH80 G-13	10	4	2
239	G-14	PVC 4" FLANGE S VANST SCH80 G-14	12	2	3
240	G-15	PVC 2.5" 90 ELL SLIP SCH80 G-15	3	4	4
241	F-13	PVC 2.5" 45 ELL SLIP SCH80 F-13	4	4	10
242	G-16	PVC 3" BALL VV HYWD SCH80 G-16	50	1	2
243	G-17	PVC 3" 3-WY BALL VV HYWD G-17	1500	1	2
244	S	PVC PRIMER P-70 QUART S	6	1	1
245	S	PVC GLUE 71 QUART S	7	1	1
246	D-7	PVC BLWH FLWMTR CF44376LH8 D-7	45	8	2
247	S	TTF 1/4" POLYPRO TUB. ROLL S	12	1	1
248	S	TTF 3/8" POLYPRO TUB. ROLL S	12	1	1
249	S	TTF 1/2" POLYPRO TUB. ROLL S	20	1	1
250	S	TTF 5/8" POLYPRO TUB. ROLL S	26	1	1
251	S	LUB SHELL MORLINA 100. S	34	5	1
252	S	LUB GEN PURP. LITH GREASE 14 OZ. S	2	1	6
253	C	SS WILS RESP CART TO5 C	15	20	111
254	C	SS WILS RESP CART R-25 C	15	2	20
255	C	3-M DUSTS/ MISTS RESP. C	1	15	36
256	C	SS 3-M SPRAY PAINT RESP 5211 C	20	4	2
257	W	BLK SODA ASH DENSE 50# BAGS W	9.1	20	57
258	PA	BLK CO2 CYLINDER 50# PA	22	2	1
259	CL	BLK CL2 CYLINDER 150# CL2 BLDG	100	2	5
260	WH	BLK HYDROCHLORIC ACID 55GAL WH	53	5	8
261	WH	BLK AQUA MAG 55GAL. WH	644	1	1.2
262	SH	ION TOP TRAY 0802697 S	100	1	1
263	C	E & H LVL TRANSMITTER FMU 860 C	1000	1	1
264	C	E & H ULTRASONIC PROBE FDU 82 C	630	1	1
265	S	PACO PUMP, 11-25707-146L01 S	907	1	2
266	C-8	PACO MECH SEAL KIT #K104-1	174	2	8
267	C-8	PACO SHAFT SLEEVE #K05002272B	60	2	9
268	C	E & H ULTRASONIC PROBE FDU 80	345	1	1
269	WH	8" PNEUMATIC BUTTERFLY VALVE	1468	1	1

270	WH	6" GATE VALVE	327	1	1
271	WH	6" PNEUMATIC BUTTERFLY VALVE	960	1	1

APPENDIX F

CONVERSION FACTORS

UNITS

1,000,000	= 1 Million	1,000,000/1 million

LENGTH

12 in = 1 ft	12 in/ft
3 ft = 1 yd	3 ft/yd
5280 ft = 1 mi	5280 ft/mi

AREA

144 sq in = 1 sq ft	144 sq in/sq ft
43,560 sq ft = 1 acre	43,560 sq ft/ac

VOLUME

7.48 gal = 1 cu ft	7.48 gal/cu ft
1000 ml = 1 liter	1000 ml/liter
3.785 L = 1 gal	3.785 L/gal
231 cu in = 1 gal	231 cu in/gal

WEIGHT

1000 MG = 1 gm	1000 mg/gm
1000 gm = 1 kg	1000 gm/kg
454 gm = 1 lb	454 gm/lb
2.2 lb = 1 kg	2.2 lb/kg

POWER

0.746 kw = 1 hp	0.746kw/1 hp

DENSITY

8.34 lbs = 1 gal	8.34 lbs/1 gal
62.4 lbs = 1 cu ft	62.4 lbs/1 cu ft

DOSAGE

17.1 mg/l = 1 grain/gal	17.1 mg/l/gpg
64.7 grains = 1 mg	64.7 grains/1mg

PRESSURE

2.31 ft water = 1 psi	2.31 ft/1 psi
0.433 psi = 1 ft water	0.433 psi/1 ft water
1.133 ft water = 1 in Hg	1.133 ft water/in mercury

FLOW

694 GPM = MGD	694 GPM/MGD
1.55 CFS = MGD	1.55 CFS/MGD

TIME

60 sec = min	60 sec/min
60 min = hr	60 min/hr
24 hr = day	24 hr/day

APPENDIX G

ABBREVIATIONS

(Source: Sacramento State University, 1984)

ac	acre
ac-ft	acre-feet
af	acre feet
amp	ampere
°C	degrees Celsius
cfm	cubic feet per minute
cfs	cubic feet per second
Ci	Curie
cm	centimeter
cu ft	cubic feet
cu in	cubic inch
cu m	cubic meter
cu yd	cubic yard
°F	degrees Fahrenheit
ft	feet or foot
ft-lb/min	foot-pounds per minute
g	gravity
gal	gallon
gal/day	gallons per day
gr	gram
GPD	gallons per day
GPM	gallons per minute
gpg	grains per gallon
gr	grain
ha	hectare
HP	horsepower
hr	hour
in	inch
k	kilo
kg	kilogram
km	kilometer
kN	kilonewton
kW	kilowatt
kWh	kilowatt-hour
L	liter

lb	pound
lbs/sq in	pounds per square inch
m	meter
M	mega
M	million
mg	milligram
mg/L	milligrams per liter
MGD	million gallons per day
mL	milliliter
min	minute
mm	millimeter
N	Newton
ohm	ohm
Pa	Pascal
pCi	picoCurie
psf	pounds per square foot
psi	pounds per square inch
psig	pounds per square inch gage
ppb	parts per billion
ppm	parts per million
sec	second
sq ft	square feet
sq in	square inches
W	watt

APPENDIX H

PAINTING AND PROTECTIVE COATINGS

PAINT AND COATING MATERIALS

a. Definitions: The term "coating materials" includes enamel paints, sealers, epoxy resins and all other paints and protective coatings, except galvanizing, whether used as a pretreatment, primer intermediate coat or finish coat.

b. General:

Paint and protective coating materials shall be sealed in containers that plainly show the designated name, formula or specification number, batch number, color, date of manufacture, name of manufacturer and manufacturer's directions for use, all of which shall be plainly legible at the time of use. Pigmented paints shall be furnished in containers not larger than five (5) gallons. Materials shall conform to the following specifications:

***** All materials shall be a standard product of a manufacturer regularly engaged in the manufacture of the product, shall essentially duplicate materials that have been in satisfactory use and shall be of the type and grade as recommended by the water and wastewater treatment industry and industrial plants.

c. Compatibility: Only compatible materials shall be used. Pay particular attention to compatibility of primers and finish coats. If necessary, apply a compatible barrier coat between all existing prime coats and subsequent field coats to insure compatibility.

SERVICE CONDITION (A): Ferrous metals, other than stainless steel, submerged or intermittently submerged in water, sludge, sewage, chemical mixtures or similar corrosive liquid should be prepared and coated in accordance with the following requirements.

a. Surface Preparation: All metal surfaces should be field sandblasted in accordance with the Steel Structures Painting Council Specification SSPC- SP10 (Near White Blast Cleaning). Weld surface, edges and sharp corners should be ground to a curve and all weld splatter removed, and all welds neutralized with thinner.

b. Application: Application should strictly conform with the manufacturer's printed recommendations. All sharp edges, nuts, bolts or other items difficult to coat should receive a brush-applied coat of the specified coating prior to application of each coat.

c. Coating Systems: Except as otherwise noted, the prime coat should have a minimum thickness of 4 mils, and the two finish coats should have a minimum total dry film thickness of 16 mils. If the finish coat is not applied within the manufacturer's recommended time period, apply an intermediate special surface conditioner before the finish coats. The total system should have a minimum of 20 mils.

Kopper's Systems:
Primer - 654
Intermediate - 300 M
Finish Coats - 300 M

Carboline's System:
Primer - Carbomastic No. 3
Finish Coats - Carbomastic No. 14

Rust-Oleum's System:
Three Coats - 9500 High Build epoxy (8 mils per coat)

Tnemec's System:
Primer - 66 at 4.0 MDFT
Intermediate - 46 H413
Finish Coat - 73 at 3.0 MDFT

SERVICE CONDITION (B): Ferrous and galvanized metals, other than stainless steel, subject to normal air exposure at the project location or equivalent attack, should be prepared and coated according to the following requirements.

a. Surface Preparation: Remove all dirt, dust, grease or other foreign matter from all surfaces before coating. Clean ferrous surfaces in accordance with the Steel Structure Painting Council specification SSPC-SP10 (Near White Blast Cleaning), and clean galvanized surfaces in accordance with SSPC-SP1 (Solvent Cleaning). Grind weld surfaces and rough edges as required to make the piece neat and ready for proper application of coating. Removes all weld splatter prior to coating.

b. Application: Apply all coatings in strict conformance with the manufacturer's recommendations. All sharp edges, nuts, bolts or other items difficult to coat should receive a brush-applied coat of the specified coating prior to application of each coat.

c. Coating System (B): Except as specified below, the prime coat should have a minimum thickness of 1 mil and two or more finish coats having a minimum total dry film thickness of 4.0 mils.

Kopper's Systems:
Primer - Kopper's No. 25 Vinyl Primer
2 Finish Coats - Kopper's No. 401 Vinyl Top Coat

Carboline's System:
Primer - Carboline Carbomastic No. 15 (5MDFT)
Finish Coats - No. 132 Urethane (2 MDFT)

Rust-Oleum's System:
Primer - 9369 Rust-O-Thane (2 MDFT)
Intermediate Coat - 9381 Rust-O-Thane (2 MDFT)
Finish Coat - 9400 Rust-O-Thane (2 MDFT)

Tnemec's System:
Primer - 33.1211 Vinoline Primer
Intermediate Coat - 34.1220 Intermediate Vinoline
Finish Coat - 35 Series Vinoline
(or)
Primer - Series 104 Epoxy Primer in 4 MDFT, and in
color closely approximating finish coat.
Finish Coat - Series Endura Shield II in not less than 1.5 MDFT

d. Coating System B on Zinc Alloy or Galvanized-Ferrous Metals: Degrease surfaces, then apply the following coating system on metal doors, frames, metal decks and ceilings as applicable.

Kopper's Systems:
Pretreat - Kopper's No. 30.
Primer - Kopper's No. 10 or No. 25
Second Coat - Kopper's 35HB
Finish Coat - Kopper's No. 401 Vinyl

Carboline's System:
First Coat - Rustbond Primer No, 8 (2 MDFT)
2 Finish Coats - No. 132 Urethane (2 MDFT each)

Rust-Oleum's System:
First Coat - 9381 Rust-O-Thane (2 MDFT)
Finish Coat - 9400 Rust-O-Thane (2 MDFT)

Tnemec's System:
First Coat - Tnemec-Grip 32.1210
Finish Coat - 73 3.0 to 5.0 dry mils

SERVICE CONDITION (C): Ferrous metals, other than stainless steel, within wet wells and similar locations subject to a corrosive atmosphere and condensation should be prepared and coated in accordance with the following requirements.

a. Surface Preparation: Sandblast all metal surfaces in accordance with the Steel Structures Painting Council Specification SSPC-SP5 (White Metal Blast Cleaning). Grind welded surfaces, edges and sharp corners to a curve and remove all weld splatter.

b. Application: Apply all coating in strict conformance with the manufacturer's recommendations. A minimum of twelve (12) hours time is required before additional coats may be applied to the prime coat, two (2) hours for the intermediate coat and two (2) hours for the finish coat.

c. Coating Systems (C): Except as otherwise specified, the prime coat shall have a minimum dry film thickness of 1.5 mils; the intermediate coat, 4.0 mils; and the final coat, 4.0 mils. The total system shall have a minimum dry film thickness of 9.5 mils.

Kopper's Systems:
Primer - Kopper's Vinyl Acrylic No. 25
Intermediate Coat - Intermediate 35HB
Finish Coat - Kopper's No. 401 Vinyl

Carboline's System:
Primer - Rustbond Primer No, 8
2 Finish Coats - Polyclad 939

Rust-Oleum's System:
Three Coats - 9000 Series High Build Vinyl (each at 3 MDFT)

Tnemec's System:
Vinyl System:
Primer - 33.1211
2 Finish Coats - 53
(or)
Epoxy System:
Primer - 104
Two Finish Coats - 104

SERVICE CONDITION (D): Coating aluminum and non-ferrous metal surfaces, including underside of access hatches and frames, subject to corrosive atmosphere and condensation should be prepared and coated in accordance with the following requirements.

a. Surface Preparation: Clean non-ferrous surfaces in accordance with SSPC- SP1 (solvent cleaning).

b. Application: Apply coatings in strict conformance with the manufacturer's recommendations.

c. Coating System (D): Conform with the following to provide total dry film thickness of 16 mils.

Kopper's Systems:
Pretreatment - Kopper's No. 30 Metal Conditioner
2 Finish Coats - Kopper's Bitumastic 300M

Rust-Oleum's System:
Pretreatment - Surfa-Etch 108 followed by thorough
rinse of clean water and allow to dry
Primer - 9369 Epoxy Primer (2 mils)
2 Finish Coats - 9500 High Build Epoxy (8 mils per coat)

Tnemec's System:
Pretreatment Primer - 32.1210 (0.5 mils)
Two Finish Coats - 46H-413

SERVICE CONDITION (E): Submerged moving parts including cables, chains, gears, pulleys, etc. should be prepared and coated in accordance with the following requirements.

a. Surface Preparation: Remove all rust, scale, dust and foreign matter by power or hand cleaning.

b. Application: Apply coating in strict accordance with manufacturer's recommendations.

c. Coating System (E): The system should have a total thickness of 25 mils and shall consist of the following.

Kopper's - Interol Grease Coating
Chevron - E.P. Roller Grease
Texaco - Rust Inhibitive Grease

SERVICE CONDITION (F): Where designated in the coating schedule, concrete which is subject to submersion and intermediate submersion in water, sludge and chemical mixtures, or which is exposed to corrosive atmospheres should be prepared and coated in accordance with the following requirements.

a. Surface Preparation: Remove all dirt, dust, form oil, curing compounds and other deleterious compounds from all surfaces. In general, the concrete should be reasonably smooth and free of pockets and cavities. Etch horizontal surfaces with a 15 to 20 percent solution of muriatic acid and thoroughly rinse with clean water. Clean vertical walls by brush blasting (NACE #4 of SSPC-SP7-63). Allow all surfaces to completely dry before applying coating.

b. Application: Apply all coating in strict conformance with the manufacturer's recommendations. Apply all coats within 24 hours of the previous coat.

c. Coating System F: The prime coat should have a minimum dry film thickness of 6 mils and the combined two finish coats should have minimum total dry film thickness of 16 mils. The total system should have a minimum dry film thickness of 22 mils.

Kopper's Systems:
Primer - Two parts Kopper's Bitumastic 300-M to no more than one part Bitumastic thinner 2000-C, mixed according to the manufacturer's recommendations.
Two Finish Coats - Kopper's Bitumastic 300M

Carboline's System:
Primer - Two parts Carboline Carbomastic No. 14 to one part thinner.
Two Finish Coats - Carboline Carbomastic No. 14

Rust-Oleum's System:
Primer - 9500 High Build Epoxy, thinned 25% with No. 60 thinner
Two Finish Coats - 9500 High Build Epoxy

Tnemec's System:
Primer - Two parts Tnemec 46H-413 to one part thinner.
Two Finish Coats - Tnemec 46H-413

SERVICE CONDITION (G): Coating for plastic and fiberglass reinforced plastic (FRP) pipe for purposes of color coding and label stenciling. Coatings to be used for this category should be certified by the pipe manufacturer to be completely compatible and non-injurious to the pipe.

a. Surface Preparation: Lightly sand pipe and wipe with a solvent to degrease and clean surface.

b. Application: Apply in accordance with the manufacturer's recommendations.

c. Coating System (G): Apply two (2) coats having a total dry film thickness of 6.0 mils.

Kopper's System: No. 401
Carboline's System: Carboline Versikote 54 or No. 938
Rust-Oleum's System: 9000 Series High Build Epoxy
Tnemec's System: 53 or 104

APPENDIX I

STATE OF ARIZONA WATER TREATMENT PLANT OPERATOR CERTIFICATION REQUIREMENTS

ELIGIBILITY REQUIREMENTS:

In order to be certified to take the State Examination for a particular grade of certification, you must meet the stated experience and education requirements.

R9-20-517

In determining whether an applicant has the experience required for certification in a particular grade, the years of acceptable experience in a lower grade, or acceptable experience obtained prior to the establishment of these regulations, or in another jurisdiction, all shall be accumulated and credited toward the total experience required for certification in the particular grade for which application is made. **ONE YEAR OF THE REQUIRED EXPERIENCE, HOWEVER, MUST HAVE BEEN ACQUIRED WITHIN THE FIVE-YEAR PERIOD PRECEDING THE DATE OF APPLICATION.**

For the purpose of these regulations, acceptable experience is considered to be experience **DIRECTLY** in the field for which application is made. Substitutions may be made for experience in closely related fields, **EXCEPT** the **ONE YEAR OF THE REQUIRED EXPERIENCE MUST BE DIRECTLY IN THE FIELD FOR WHICH CERTIFICATION IS GRANTED.**

Requirements for grades are:

GRADE 1 - Requires:

a. Three years experience, OR
b. Two years high school or equivalent and two years experience, OR
c. Four years high school or equivalent and one year experience

GRADE 2 - Requires:

a. Four years experience, OR
b. Two years high school or equivalent and two years experience, OR
c. Two years college or equivalent post high school education and one year experience

GRADE 3 - Requires:

a. Five years experience and Grade 2 certification, OR

b. Two years high school or equivalent, four years experience, AND Grade 2 certification, OR
c. Four years high school or equivalent, three years experience AND Grade 2 certification, OR
d. Two years college or equivalent post high school education and two years experience AND Grade 2 certification, OR
e. Four years college or equivalent post high school education AND two years experience, OR
f. College degree in engineering, biological sciences, chemical sciences, or closely related technical field and one year experience

GRADE 4 - Requires:

a. Four years high school or equivalent and four years experience, including one year at Grade 3 certification, OR
b. Two years college or equivalent post high school education and three years experience, including one year at Grade 3 certification, OR
c. College degree in engineering, biological sciences,chemical sciences, or a closely related technical field and one year experience at Grade 3 certification.

R9-20-512 RECIPROCITY

The Department MAY issue certificates without examination to applicants who hold valid certificates issued under laws of any other state, territory or the District of Columbia, or issued under a voluntary certification program of any other state, provided the out-of-state certificate was issued as the result of passing an examination equivalent to the examination given by the Department for the same grade. Experience and educational requirements for certification as set forth in these regulations (R9-20-517) shall apply to all such applicants.

R9-20-517 TEMPORARY CERTIFICATION

Temporary Grade 1 certification for water distribution, water treatment, wastewater collection or wastewater treatment may be granted to any qualified person who has successfully completed a training course approved by the Department for that purpose and who has passed the corresponding certification examination. The temporary certificate will be valid for 18 months, and is not renewable. An operator temporarily certified at Grade 1 may operate any Grade 1 water or wastewater treatment facility of the type for which he is certified for a period not to exceed one year. Upon certification or proof that the operator has completed of successful work experience in a water or wastewater facility, the Department shall issue the appropriate Grade 1 certificate.

Temporary Grade 3 certification to operate a specific water or wastewater treatment plant for a period of one year may be issued to an applicant who holds a bachelor's degree in engineering, biological sciences, chemistry, or a closely related technical field, upon his passing the Grade 3 water or wastewater treatment examination. A temporary certificate is valid only for the facility for which it is issued and cannot be reissued. Upon verification or proof that the operator has completed one year of successful full-time on-site operation, the Department shall issue the appropriate Grade 3 certificate.

THE DEADLINE FOR SUBMITTING ALL APPLICATIONS IS NOVEMBER 15 FOR THE JANUARY EXAM AND MARCH 15 FOR THE MAY EXAM.

APPLICATION:

In completing your application be very specific as to experience, giving all dates of experience, (from-to), supervisor's name and phone number. All experience shall be subject to verification.

Proof of education shall be submitted with application.

Use supplemental sheets if additional space is required.

Do not submit applications until all requirements for the grade level being applied for are met.

For further information contact:

ARIZONA DEPARTMENT OF HEALTH SERVICES
Attention: Certification Unit
2005 North Central, Room 202
Phoenix, AZ 85004
Phone: (602) 257-2274